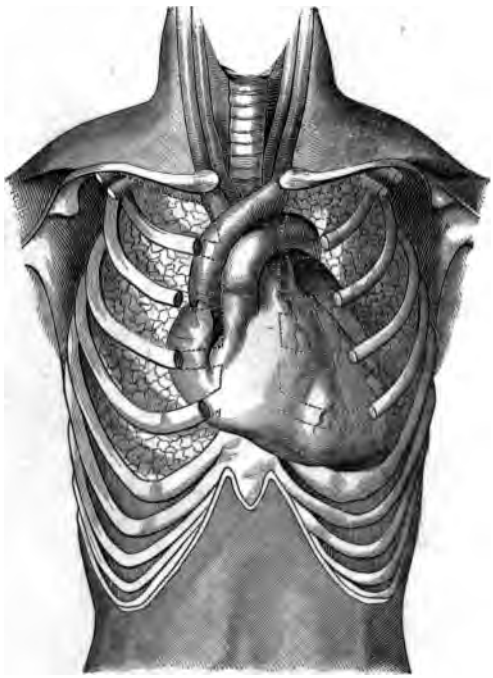


THE HEART AND LARGE BLOOD-VESSELS.

HUMAN

ANATOMY, PHYSIOLOGY, AND HYGIENE.

A TEXT-BOOK

FOR

Schools, Academies, Colleges, and Families.

BY

JOSEPH C. MARTINDALE, M.D.,

LATE PRINCIPAL OF MADISON GRAMMAR SCHOOL, PHILADELPHIA; AUTHOR OF "FIRST LESSONS IN NATURAL PHILOSOPHY;" "HISTORY OF THE UNITED STATES FOR SCHOOLS," ETC.

PHILADELPHIA:
ELDREDGE & BROTHER,
17 North Seventh Street.
1874.

J. FAGAN & SON,
ELECTROTYPERS, PHILAD'A.

CAXTON PRESS OF SHERMAN & CO.

PREFACE.

IN preparing this book, we have aimed to give facts in clear, concise language, and as free as possible from technical terms. All speculations and hypotheses have been omitted as inconsistent with a work of this kind.

Our endeavor has been to present the subject, both to the student and to the general reader, in such a form, that the facts may be easily grasped and readily retained.

The Anatomy and Physiology are given first; because a knowledge of the location and the functions of the organs of the body, is needed before we can understand how to preserve them in a state of health. We must be acquainted with a law before we can keep it; and we must know the laws which govern our systems, before we can observe them.

The body is composed of many organs, each of which performs its part in the economy of the system; yet the functions of these organs are closely connected with each other, and they all act so as to produce a unity and harmony in the whole being. The Laws of Health, or Hygiene, are not

applied so much to the preservation of each part separately, as to the preservation of the entire system; hence, their application can be better understood after the Anatomy and Physiology have been learned.

This book is fully illustrated by such engravings as will give a clear idea of the facts mentioned in the text; and neither pains nor expense have been spared to make it as complete as possible in this respect.

The Appendix contains much useful information under the following heads: Care of the Sick; Asphyxia from Drowning; Disinfectants; Poisons and their Antidotes; a Glossary of Diseases; and a Glossary of Words.

A copious Index is appended, so that reference may be made to the text of the book for any desired information.

J. C. M.

PHILADELPHIA, 1872.

CONTENTS

CHAPTER I.

General Remarks.

CHAPTER II.

Motor Apparatus.

CHAPTER III.

Nutritive Apparatus.

CHAPTER IV.

Sensory Apparatus.

CHAPTER V.

Hygiene.

CHAPTER VI.

Development and Death.

CHAPTER VII.

Appendix.

LIST OF ILLUSTRATIONS.

ANATOMY,

PHYSIOLOGY, AND HYGIENE.

CHAPTER I.—General Remarks.

SECTION I.

INTRODUCTION.

1. ALL bodies, or masses of matter, on the earth may be separated into two classes; the **organized** and the **unorganized.** The organized bodies comprise all animals and all vegetables; the unorganized bodies comprise the air, gases, water, soils, ores, stones, and rocks.

2. All organized bodies are composed of **ultimate elements** combined and arranged according to certain fixed laws, yet controlled by a Vital or Life-force. All unorganized bodies are composed of similar ultimate elements arranged according to fixed laws, yet without any Life-force. These ultimate elements are called organic, when they enter into the composition of organized bodies; and inorganic, when they enter into the composition of unorganized bodies.

3. **Every organized body is living or has been living;** its origin is from a parent; it is developed by a growth or increase in all its parts; it must be nourished by food; it has the power of reproduction; and it is subject to death. **An**

unorganized body has no life, no parent, no growth, no food, no power of reproduction, and no death.

4. All organized bodies are comprised in *two classes;* animals and vegetables. **Animals** absorb oxygen and exhale carbonic acid; and they require organic food, such as meat and vegetables, for their support. **Vegetables** absorb carbonic acid and exhale oxygen; and they obtain their nourishment from unorganized substances, such as ammonia, carbonate of lime, and phosphate of lime.

5. **Anat'omy** treats of the component parts of an organized body, and explains the structure and position of its organs while in a state of rest. The anatomy of a body is the same in death as in life. **Physiol'ogy** treats of the body during life only, and explains its growth, its movements, and the various changes which are constantly going on in it. These changes are called Vital phenomena, or the phenomena of Life, and end when death takes place.

6. **All organized bodies are for the most part composed of organic cells,** which are spherical in their primitive form, having a cell wall and cell contents, with a filamentary appendage. A second and much smaller cell, called the nucleus, is generally found among the contents of the primitive cell. These cells undergo more or less change in the formation of the different parts of animals and vegetables. Sometimes they retain nearly their primitive form, as in the glandular cells of the body; but at other times they are so modified that they can scarcely be recognized, as in the fibrous tissues where the cells are in the form of fine filaments.

Fig. 1.

Fig. 1. Two organic cells from the submaxillary gland, highly magnified.

7. **The primitive cell in all organized bodies is alike.** It is the starting-point in the formation of them all; thus showing a *unity of plan* pervading the whole organic world. In the different species of animals, the corresponding parts of the body are very similar; thus the composition of bone in one animal differs but little from that in another; and this is

true of the muscles, the skin, the hair, the blood, and indeed of all parts of the body, so that the whole animal kingdom is united into one general class by the similarity of structure.

8. Although there is great *similarity* in the composition of the structure of all animals, yet there is great *diversity* in the form, the shape, and the general arrangement of those structures. Thus the heart and blood-vessels differ in size, in shape, and in arrangement, in the different animals. This is also the case with the lungs, the muscles, the bones, and other organs. It is this diversity in the development of an animal, by which it is made to conform to an established type, that gives rise to the different species, and that enables us to distinguish one species from another, and even to distinguish individuals of the same species, and know them apart.

9. Each species of animals varies in size, in shape, and in general arrangement of structure; hence, the Anatomy and Physiology of one species will vary more or less from those of every other species, although all will conform in general characters. It is our province in this work to speak principally of the Anatomy and Physiology of the human species; yet reference will be made to other species, whenever such reference will aid in the illustration of the theme under consideration.

10. The study of the Anatomy and the Physiology of the human body may naturally be separated into *three divisions*, or chapters, corresponding with the functions of the system. The three divisions are: **the Mo'tor Apparatus,** which comprises the bones, the muscles, and the joints; **the Nu'tritive Apparatus,** which includes everything that relates to the support and preservation of the entire body; and **the Sen'sory Apparatus,** which protects the individual by means of motion, sensation, volition, and consciousness.

11. **The Prim'itive Cell** is the starting point in the formation of a living body. **A Tis'sue** is the texture of which any part of the body is composed, and is itself formed from the

primitive cell. **An Or'gan** is any part of the body composed of one or more tissues, and capable of a special function, as the lungs. When several organs similar in structure are taken together, they are called a **Sys'tem**, as the nervous system. When two or more systems, or when several organs differing in structure, are taken together, they are called an **Appara'tus**, as the nutritive apparatus.

12. When we contemplate the world in which we live, and become acquainted with the laws by which it is governed, we are impressed with the fact that there is a *unity* in the plan, and a *system* in the arrangement of all its parts. Although the finite mind of man is limited in its comprehension, yet enough can be understood to know that One greater than man must have conceived and arranged all these things. The harmony that everywhere exists amid all this diversity of form and shape; the order and regularity exhibited in the manifold operations of nature; and the unchangeable law by which every living thing brings forth according to its kind, unmistakably point to an Omniscient and Omnipotent Being as the Creator and Ruler of the universe!

QUESTIONS.

SECTION I.

1. Name the classes into which all matter may be separated. What does each class comprise?
2. Give the composition of organized bodies. Of unorganized bodies.
3. What are the distinguishing features between organized and unorganized bodies?
4. Name the classes into which organized bodies are divided. State the distinctions between them.
5. Define Anatomy. Physiology.
6. Define the primitive form of organic cells. How are they modified in the formation of animals and vegetables?
7. What may be said of the primitive cell in organized bodies? What of their similarity of structure?
8. What is said of the difference of structure in organized bodies? To what does this difference give rise?

9. Why do the Anatomy and Physiology of one species differ from those of another species?

10. How are the Anatomy and Physiology naturally divided? Define each division.

11. In what is the primitive cell the starting point? What is a tissue? An organ? A system? An apparatus?

12. What is said of the unity and of the system in the creation of the world?

SECTION II.

COMPOSITION OF THE BODY.

1. **There are fourteen Ul'timate El'ements,** or substances which enter into the composition of the human body. Of these, Ox'ygen, Hy'drogen, Car'bon, and Ni'trogen, exist in all plants, and in all animals. The remaining elements are Cal'cium, Potas'sium, So'dium, Chlo'rine, Phos'phorus, Sul'phur, Sil'icon, I'ron, Magne'sium, and Flu'orine.

2. The ultimate elements seldom exist alone in the body; but they are variously combined with each other, forming the proximate elements which constitute the fluids and solids of the body.

3. **The Prox'imate El'ements** are divided into *three classes.* The first class are all inorganic, and comprise such substances as water, chloride of sodium, and phosphate of lime. The second class are crystallizable substances of organic origin, and comprise starch, sugar, and fat. The third class are all organic, and are often called "albuminoid" substances, or "protein compounds," and comprise such substances as albumen, fibrin, and casein.

4. The proximate elements of the *first class* are: Water, Chloride of Sodium, Phosphate of Lime, Carbonate of Lime, Chloride of Potassium, Carbonate of Potassa, Phosphate of Magnesia, Phosphate of Soda, Phosphate of Potassa.

5. **Water** is present in all the solids and fluids of the body. It gives fluidity to the blood and the secretions, so that they

move more easily through the body; and it keeps the solids in their natural condition, so that they can perform their functions more readily.

6. Water is estimated to constitute more than *two-thirds* of the entire weight of the body. The amount of it taken daily into the system, has been calculated to be about **four and a half pounds.** This comprises all the water taken as drink, and all that is contained in the food. After the water has performed its office, it passes from the body by the lungs, the skin, and other organs.

7. **Chloride of Sodium** is found in all the fluids and solids of the body, except in the enamel of the teeth. It is useful in helping to regulate the passage of fluids through animal membranes, and it aids in digestion. Its use, as an addition to the food, is universal among all races and classes of mankind; and even the lower animals partake of it freely. The system requires to be frequently supplied with it.

8. **Phosphate of Lime** exists in all the solids and fluids of the body. It forms a large part of the bones and teeth, and gives them firmness and solidity. It may be dissolved out of the bones by dilute muriatic acid, leaving behind only the animal substance, which may then be bent in any direction without breaking. The phosphate of lime exists in all kinds of meat and vegetables, and in nearly all fruits.

9. **Carbonate of Soda** is found in the bones, the blood, and the saliva. It helps to dissolve the albumen in the blood. It exists in most fruits and vegetables; but the greater part of it is formed in the body.

10. **Chloride of Potassium** is found in the muscles, the blood, and other fluids and tissues of the body. It is readily soluble in water, and is always found in a fluid form. It is mostly obtained from the food.

11. **Carbonate of Lime** is found in the bones. The small bones of the ear are formed almost entirely of it.

12. **Carbonate of Potassa** is found in the bones, blood, and lymph. It helps to dissolve the albumen in the blood.

13. **Phosphate of Magnesia, of Soda, and of Potassa,** exist in very small quantity in all the solids and fluids of the body.

14. The proximate elements of the *second class* are: Starch, Sugars, Fats.

15. **Starch** is found in nearly all vegetable substances used for food. During the process of digestion, it is converted into sugar. It has been found in the human brain, in the form of starch granules.

16. **Sugar** is obtained from both animal and vegetable food, and particularly from fruits. There are several varieties of it, which vary somewhat in their chemical composition.

17. **Fat** is derived from both animal and vegetable food. It is most abundant in the adipose tissue of the body; but it also occurs in the marrow of the bones. The human body requires food containing both sugar and fat for its support.

18. The proximate elements of the *third class* are: Fibrin, Albumen, Casein, Globulin, Pepsin, Pancreatin, Mucosin, Ostein, Cartilagin, Musculin, Hematin, Melanin, Biliverdin.

19. **Fi'brin** is the substance in the blood and lymph, which causes them to coagulate spontaneously when removed from the circulation.

20. **Albu'men** occurs in the blood, the lymph, and the fluids of the serous cavities of the body. It coagulates at a temperature of 160°, and in many respects resembles the white of an egg.

21. **Cas'ein** exists in milk. It is coagulated by acids, and by the juices of the stomach.

22. **Glob'ulin** forms the principal part of the red corpuscles of the blood.

23. **Pep'sin** is found in the gastric juice; **Pancreat'in,** in the pancreatic juice; and **Muco'sin** in the secretions of mucus, from the different mucous membranes.

24. **Os'tein** is the substance of the bones, and **Cartilag'in** is the substance of cartilage; both of which are changed into gelatin, or glue, by long boiling.

25. **Mus'culin** is the principal substance of the muscular fibre. It has the power of contractility during life.

26. **Hem'atin** is the coloring matter of the red corpuscles of the blood.

27. **Mela'nin** is the coloring matter in the eye, the hair, and the skin. It is very abundant in the black and brown races; but less so in the yellow and white races.

28. **Biliver'din** is the coloring matter of the bile. On exposure to the air, in a fluid condition, it absorbs oxygen, and changes to a grass-green color.

29. **The albu'minoid substances** form a large part of the tissues of the body, and must be regularly supplied for its preservation. They are found in the cereal grains, in meats, in eggs, and in milk.

QUESTIONS.

SECTION II.

1. What is said of the ultimate elements in the body?
2. What is said of the combination of the ultimate elements?
3. How are the proximate elements divided? Define each class.
4. Name the proximate elements of the first class.
5. What is remarked of the use of water in the body?
6. What is said of the quantity of water in the body?
7. What is said of Chloride of Sodium in the system?
8. What of the Phosphate of Lime?
9. What of the Carbonate of Soda?
10. What of the Chloride of Potassium?
11. What of the Carbonate of Lime?
12. What of the Carbonate of Potassa?
13. What of the Phosphate of Magnesia, of Soda, and of Potassa?
14. Name the proximate elements of the second class.
15. What is said of Starch?
16. What is said of Sugar?
17. What is said of Fat?
18. Name the proximate elements of the third class.
19. Define Fibrin. 20. Albumen. 21. Casein. 22. Globulin. 23. Pepsin, Pancreatin, Mucosin. 24. Ostein, Cartilagin. 25. Musculin. 26. Hematin. 27. Melanin. 28. Biliverdin.
29. What is remarked of the albuminoid substances?

CHAPTER II.—Motor Apparatus.

The motor apparatus of the body consists of the Bones, the Joints, and the Muscles.

SECTION I.

THE TISSUES OF THE BODY.

1. **The tissues of the body** are the fibrous, the connective, the cartilaginous, the fibro-cartilaginous, the elastic, the adipose, and the muscular tissues.

2. **Fi'brous tissue** is white or yellowish-white, while in the body; but it becomes yellow when taken out and dried. It is very flexible, but inelastic, and is the strongest of all the animal tissues; therefore, it is admirably adapted to connect and support the other tissues and organs of the body.

Fig. 2.

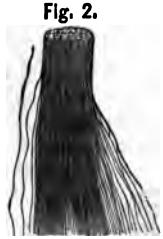


Fig. 2. Filaments of fibrous tissue, highly magnified.

3. The fibrous tissue of the skin of animals is the part converted into leather by the process of tanning. When this tissue is boiled, it is resolved into gelatin, and thus furnishes the glue of commerce.

4. Fibrous tissue is composed of very fine filaments or threads. When these filaments are all parallel to each other, the tissue will not stretch; but when they cross each other, it admits of more or less extensibility.

5. **Connec'tive, or Are'olar tissue,** is composed of filaments of fibrous tissue, which interlace or cross each other. It is white, soft, and slightly extensible, yet very strong, so that it holds the bones, muscles, skin, nerves, and blood-vessels in their places without impeding their movements. It is the tissue which connects the different parts of the body together; hence, it is appropriately called *connective* tissue.

Fig. 3.

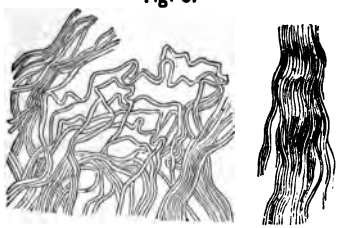


Fig. 3. Filaments of connective tissue, highly magnified.

6. **Car'tilage, or gristle,** is a smooth, elastic, flexible substance, whitish in appearance, and softer than a bone, but harder than a ligament. It holds a middle place between the fibrous tissue and bone; hence, its adaptation to such parts as require to be kept in shape, and at the same time to have a moderate degree of motion.

7. At first, all the bones of the body are in the form of cartilage; but they soon ossify and form the skeleton. These cartilages are called temporary cartilages, to distinguish them from the permanent cartilages, which are not changed into bone.

Fig. 4.

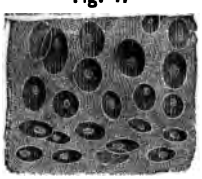


Fig. 4. Cartilage cells imbedded in a matrix, highly magnified.

8. Cartilage consists of a solid matrix, resembling ground glass in appearance. The matrix contains nucleated cells, which are single, or are arranged in oval groups.

9. **Fi'bro-car'tilage** consists of a fibrous matrix with imbedded cartilage cells. It comprises every form of intermixture between the pure fibrous tissue and the pure cartilage. Fibro-cartilage combines the strength of the fibrous tissue with the elastic property of the cartilage; and it is well adapted to the firmest union of bones, accompanied with moderate flexibility.

10. **Elas'tic tissue** is a tough, dull-yellow substance composed of coarse fibres. It is usually mingled with the fibrous tissues, and is seldom found alone in masses of any important size.

Fig. 5.

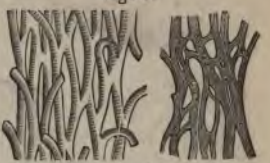


Fig. 5. Fibres of elastic tissue, highly magnified.

11. **Ad'ipose, or fat tissue,** does not seem to be essential to the constitution of any organ. It is composed of delicate cells, which are filled with a yellowish substance, called fat. It is found in all the connective tissue of the body, and it occupies the spaces among the muscles, the hollows in the cheeks, the temples, and behind the eyeballs; and it occurs almost everywhere beneath the skin, giving roundness and beauty to the human form. It is never found in the eyelids, the eyeballs, the brain, or the spinal cord.

Fig. 6.

Fig. 6. Adipose, or fat tissue, with connective tissue, highly magnified.

12. **Mus'cular tissue** is composed of soft, red fibres, called *muscular* fibres; and these fibres are collected together into *bundles* or *fasciculi*. Both the fibres and the fasciculi are surrounded by connective tissue, which holds them together. When viewed through the microscope, these fibres are distinctly striated or marked transversely; therefore, they are called *striated* muscular fibres.

Fig. 7.

Fig. 7. A piece of muscle, slightly magnified, showing the bundles or fasciculi.

13. The muscular coat of the stomach, the intestines, and the blood-vessels, are composed of fibres which are not striated, and are, therefore, called *unstriated* muscular fibres. All muscular fibres possess the power of **contractility**, by which they are shortened, and their extremities brought nearer together. Upon this power depend all the motions of the body.

QUESTIONS.

SECTION I.

1. Name the tissues of the body.
2. Describe the fibrous tissue.
3. Into what may the fibrous tissue of animals be converted?
4. What is said of the filaments of fibrous tissue?
5. Describe the connective tissue.
6. Describe cartilage. Of what use is it?
7. From what are the bones formed? What name is given to these cartilages, and why?
8. Of what does cartilage consist?
9. Describe fibro-cartilage.
10. Describe elastic tissue.
11. Describe adipose tissue. Where is it found?
12. Of what is muscular tissue composed? How does it appear under the microscope?
13. What is said of the unstriated muscles? What power is possessed by muscular fibres?

SECTION II.

ANATOMY OF THE BONES.

1. **The Bones** are hard and firm, and are placed in the interior of the body, where they serve as a frame-work, or **Skeleton,** for preserving its general shape, for the protection of its most important organs, and for the attachment of muscles. The bones are to the body what the frame-work is to a building.

2. **The number of bones** in the body varies at different periods of life. Many of them are in two or more pieces in the child; yet they afterwards grow together, forming but one bone in the adult. The number of bones usually given, **is two hundred and eight,** besides the thirty-two teeth.

Of these bones, thirty are in the head, fifty-four in the trunk, sixty-four in the upper limbs, and sixty in the lower limbs.

3. The bones in the body differ in size and form, and may be divided into *four classes:* the long bones, as in the upper and lower limbs; the broad bones, as in the skull; the short bones, as in the wrist and ankle; and the irregular bones, as in the vertebræ.

4. **The long bones** * are more or less cylindrical, and are mostly hollow, like a tube. The main part of a long bone is called its **shaft** or body, and the ends are called its **extremities.** The extremities of the long bones are larger than the shaft, thus furnishing a broader base of support at the joints. When the end of the bone is rounded, as in the thigh-bone, it is called a **head.**

5. An elevation or prominence on a bone is called a **process.** A single aperture or orifice in a bone is called a **fora'men,** and two or more apertures are called **foram'ina.**

6. While the bones are in the body they are of a bluish-white color, and are slightly tinged with pink from the blood which is in them. When removed from the body, and exposed to the air and the light, they gradually assume a chalk-white appearance. In the young, the bones are tough, and somewhat elastic, so that they are not easily broken; but as the person advances in life, they become harder and more brittle.

7. The bones are nearly twice as heavy as water. They are composed of **animal matters and mineral matters.** In early life, the proportion of these matters is about equal; but as the person grows older, the mineral matters increase, until they compose fully three-fourths of the material of the bones; hence, they are more easily fractured in old persons than in the young.

* In Fishes, the bones are perfectly solid; in Reptiles, they contain a few cavities; in the Mammalia, many of them are hollow, and are filled with fat; and in Birds, many of them are hollow, but are filled with air, which adds to their lightness.

8. When bones are burned, so as to char the animal matter, they become black, and very brittle, and are then called *bone-black;* but when the animal matter is entirely consumed, the mineral parts left are of a pure white color, and yield the *phosphorus* of commerce.

9. When bones are steeped in dilute muriatic acid, the mineral matters are dissolved out, leaving only the cartilage, or animal matter, which retains the original form of the bone, and which is very flexible, so that it may even be tied into a knot.

10. The bones are mostly composed of an exterior layer, which is firm and compact; and an interior layer, which is loose and spongy.

11. The shaft of the long bones is mostly composed of the compact substance, but their extremities are more or less spongy. The long bones are in the form of hollow cylinders, and are filled with a soft, yellow fat, called **mar'row or medul'la.**

12. The broad bones have two layers of compact substance, with a layer of spongy substance intervening. The short bones, and the irregular bones, have a thin layer of compact substance externally, while the greater part of their bulk is composed of spongy material.

13. **The compact substance** gives strength to the bones; hence, it is found most abundantly in the shafts of the long bones, and in bones that are thin, yet require considerable strength, as in the skull. **The spongy substance** increases the size of the bones, without increasing their weight; therefore, it occurs most abundantly near the joints, and in all bones where an enlarged surface is needed for the attachment of muscles. It also helps to reduce the force of falls and blows.

14. The exterior surface of the bones, except at the joints, is covered with a fibrous membrane, called **perios'teum.** In early life, this membrane may be separated from the bone; but it afterwards becomes so blended with the bone as not to

Fig. 8.

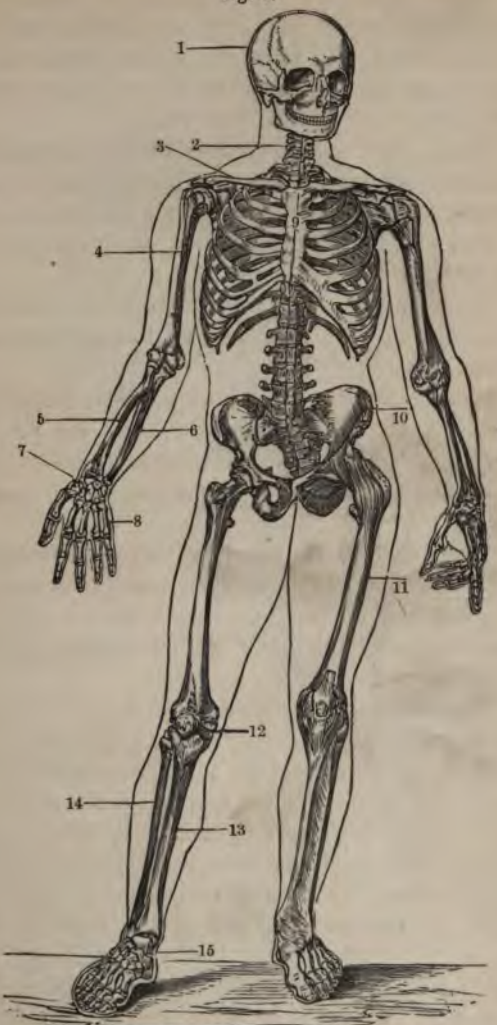


Fig. 8. A FRONT VIEW OF THE HUMAN SKELETON. — 1, The skull; 2, the spinal column; 3, the clavicle; 4, the humerus; 5, the radius; 6, the ulna; 7, the carpus; 8, the meta-carpus; 9, the sternum; 10, the pelvis; 11, the femur; 12, the patella; 13, the tibia; 14, the fibula; 15, the tarsus.

be easily detached from it. It contains the blood-vessels which nourish the bone, and it serves as a medium of attachment for the muscles and ligaments. A similar membrane lines the interior surface of the long bones, and is called the **endos'teum.**

15. At first all bones are composed of cartilage, but afterwards deposits of calcareous matter are made in one or more points, called the **centres of ossification.** These deposits continue to increase until the whole bone is completely ossified. **Ossification** in all the bones of the body is not completed until about the twenty-fifth year.

16. *The long bones grow in length* by a continuous growth and ossification of cartilage at their extremities; the broad bones grow in the same manner from their edges or borders; but the short bones grow from all parts of their external surfaces.

17. **Calca'reous deposits** continue to be made in the bone throughout life; thus, a growth of new bone is constantly added, while the old and effete bone decays, and is removed. The bones of the body are, therefore, changed many times during a long life.

18. **The bones of the Head** are divided into those of the skull, the face, and the ear.

19. **The Skull** is composed of eight bones: the two **Tem'poral** bones, one on each side of the cranium, containing the orifice leading to the ear; the two **Pari'etal** bones, situated at the top of the head, and united together in the median line; the **Occip'ital** bone, occupying the posterior part of the skull, resting on the spinal column, and having a large oval foramen for the passage of the spinal cord; the **Front'al** bone, forming the forehead; the **Sphe'noid** bone, situated across the base of the cranium, from side to side, and containing numerous and important foramina; and the **Eth'moid** bone, situated at the base of the brain, between the orbits, and behind the nose.

20. The bones of the skull are composed of *two layers* of compact substance, with spongy substance intervening. The

Fig. 9.

Fig. 9. A View of the Skull and Face. — 1, Frontal bone; 2, parietal bone; 3, temporal bone; 4, inferior maxillary bone; 5, superior maxillary bone; 6, malar bone; 7, nasal bone; 8, lachrymal bone.

outer layer is tough and strong; while the inner one, called the vitreous layer, is comparatively brittle.

21. Nearly all the bones of the skull are united by **sutures,** the most of which are of the serrated variety. Before the twelfth year the sutures are not fully developed; but after that time they are very little changed, until old age, when the bones are apt to grow together, so as nearly or quite to obliterate the sutures.

22. **The skull** is an egg-shaped, bony case, and is especially adapted, from its great strength, to protect the tender brain within it from being injured by external objects.

23. **There are fourteen bones in the Face,** two of which are single, and twelve are in pairs. The single bones are the **Vo'mer,** which separates the nostrils from each other; and the **Infe'rior Max'illary,** or lower jaw-bone, which is the largest, and the only movable bone of the face.

24. The bones of the face, which are in pairs, are the two **Supe'rior Max'illary** bones, forming the upper jaw; the two **Pal'ate** bones, situated back of the upper jaw, and forming the greater part of the roof of the mouth; the two **Lach'rymal** bones, one on the inner wall of each orbit; the two **Na'sal** bones, forming the bridge of the nose; the two **Tur'binated** bones, in the nostrils; and the two **Ma'lar** bones, forming the most prominent part of the cheeks.

Fig. 10.

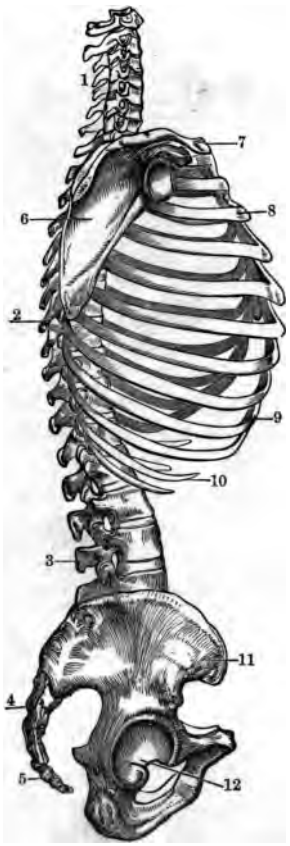


Fig. 10. A Side View of Spinal Column, Thorax, and Pelvis.—1, Cervical vertebræ; 2, dorsal vertebræ; 3, lumbar vertebræ; 4. sacrum; 5, coccyx; 6, scapula; 7, clavicle; 8, true ribs; 9, false ribs; 10, floating ribs; 11, hip-bone; 12, acetabulum.

25. **Each Ear** contains four very small bones, which aid in the sense of hearing. They are named the **Mal'let**, the **An'vil**, the **Stir'rup**, and the **Orbic'ular** bone; and are so very small that the four together weigh only a few grains.

26. **The bones of the Trunk** are separated into those of the spinal column, the ribs, the sternum, the pelvis, and a bone at the root of the tongue, called the **Hy'oid bone.**

27. **The Spinal Column** is composed of twenty-four bones, called vertebræ. It extends from the skull to the pelvis. Each vertebra consists of a main part, called the body, which is a half cylinder in shape, with the upper and the lower surface nearly flat; it has seven projections, called processes,

which serve as points of attachment for muscles and ligaments. These processes are arranged so as to form a canal, behind the bodies of the vertebræ, for the spinal cord.

28. **The Ver'tebræ** are divided into three classes: the cervical, or neck vertebræ; the dorsal, or back vertebræ; and the lumbar vertebræ.

Fig. 11.

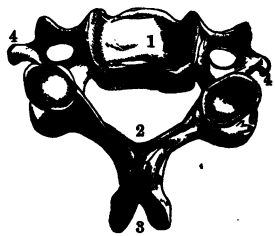


Fig. 11. A VERTEBRA OF THE NECK. 1, The body of the vertebra; 2, the spinal canal; 3, 4, the processes.

29. **The Cer'vical vertebræ** are seven in number, and are smaller than those of either of the other classes. Their upper surface is concave, and the lower surface convex, so that they interlock with each other. The processes are all short, and nearly horizontal. The first cervical vertebra is called the **Atlas**, from its supporting the head; and the second vertebra is called the **Axis**, because the head rotates, or turns on it.

30. **The Dor'sal vertebræ** are twelve in number, and furnish support for the twelve ribs which are attached to them. The processes of the dorsal vertebræ are longer, and their bodies larger, than those of the neck, and their upper and lower surface are both flat.

31. **The Lum'bar vertebræ** are five in number, and extend from the thorax to the pelvis. The processes of the lumbar vertebræ are longer and less horizontal, and their bodies are larger, than those of either of the other vertebræ. Their upper and their lower surface are both flat.

32. Between each two vertebræ is a plate of fibro-cartilage, called an **Interver'tebral ligament**, which holds them firmly together, and which gives elasticity to the spinal column, so that the force from walking, running, leaping, or falling, seldom produces any injury. These plates vary in thickness, so as to give the forward and backward curve to the spinal column.

33. **The Yel'low ligaments,** composed of yellow, elastic tissue, number twenty-three pairs. They are situated between the arches of the vertebræ behind, which they join together so as entirely to inclose the spinal canal. They combine great strength with considerable freedom of motion.

34. **The Ante'rior Ver'tebral ligament** extends the entire length of the spinal column, covering the front of the bodies of the vertebræ, and joining them firmly together. **The Poste'rior Ver'tebral ligament** covers the posterior part of the bodies of the vertebræ, within the spinal canal, and helps to bind them firmly together.

35. **The Ribs** are twenty-four in number; twelve on each side. They are all united in the back with the spinal column. In front, the seven upper ribs are united with the breast-bone, or sternum, by means of cartilage, and are called the *true ribs;* the next three are united to each other by cartilage, and are called the *false ribs;* while the lowest two ribs are not united in front, and are, therefore, called the *floating ribs.* In length, the ribs increase from the first to the eighth, and decrease from the eighth to the twelfth; but, in width, they gradually diminish from the first to the last.

36. **The Ster'num,** or breast-bone, is situated in the middle of the front part of the thorax. It is in several pieces in childhood; but these are united in later years into one bone.

37. The cavity formed by the dorsal vertebræ, the ribs, and the sternum, is called the **Tho'rax, or Chest.** It is conical in shape, with its apex at the neck; but tight lacing often changes its form into an oval. It is admirably adapted to protect the lungs, the heart, and the blood-vessels which are within it, and at the same time to permit the movements of these organs.

38. **The Pel'vis** is composed of four bones; the sacrum, the coccyx, and the two hip-bones.

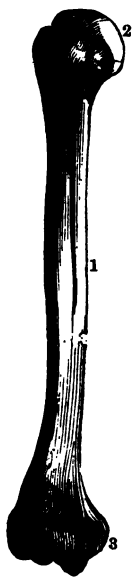
39. **The Sa'crum** is a triangular bone situated between the hip-bones, at the back part of the pelvis. It is concave in front and convex behind, and is a continuation of the spinal column.

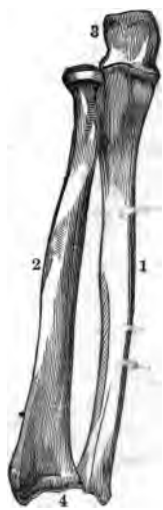
40. **The Coc'cyx** is joined to the lower end of the sacrum. In early life it consists of four pieces, but these are afterwards united into one bone.

41. **The Hip-bones** are attached to the sacrum by strong ligaments. They are united in front by ligaments in early life, but afterwards grow together, forming a bony union. In the side of each hip-bone is a deep socket, or cup-like cavity, called the **acetab'ulum,** in which the head of the thigh-bone is placed.

42. The bones of **each upper extremity** number thirty-two. They are the clavicle, the scapula, the humerus, the

Fig. 12. Fig. 13. Fig. 14.





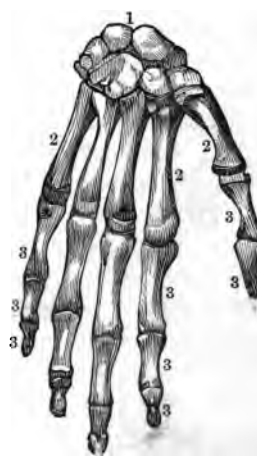


Fig. 12. THE HUMERUS. — 1, The shaft; 2, the head of the humerus at the shoulder; 3, the end which articulates at the elbow.

Fig. 13. THE ULNA AND RADIUS. — 1, The ulna; 2, the radius; 3, the end which articulates at the elbow; 4, the end which articulates at the wrist.

Fig. 14. THE WRIST AND HAND. — 1, The carpal, or wrist bones; 2, the meta-carpal bones of the hand; 3, the phalanges of the thumb and the fingers.

radius and ulna, the carpus, the meta-carpus, and the phalanges.

43. **The Clav'icle, or collar-bone,** is situated in front of the upper part of the thorax, and extends from the sternum to the scapula. Its use is to prevent the shoulders from being drawn towards the sternum.

44. **The Scap'ula, or shoulder-blade,** is a broad, thin, triangular bone, situated at the upper back part of the thorax. It is held in position entirely by the muscles which envelop it.

45. **The Hu'merus, or arm-bone,** is a long, cylindrical bone, extending from the glenoid cavity of the scapula to the bones of the forearm, at the elbow.

46. **The Ul'na** is on the lower or inner side of the forearm, and is a little longer than the radius. It articulates with the humerus at the elbow, forming a hinge joint.

47. **The Ra'dius** is on the upper or outer side of the forearm (the thumb side). It is attached to the ulna, both at the elbow and at the wrist. It also articulates with the carpal bones, forming the wrist-joint.

48. **The Car'pus** is composed of eight bones, arranged in two rows. These bones are strongly bound together by ligaments, and form the wrist.

49. **The Meta-car'pus** is composed of five bones, forming the palm of the hand. They extend from the wrist to the first bones of the fingers and the thumb.

50. **The Phalang'es** are the three bones in each finger, and the two bones in the thumb. The fingers are named the index, the middle, the ring, and the little finger.

51. **The bones of the lower extremities** are larger and stronger than those of the upper extremities; because they are required to support the weight of the trunk, the upper limbs, and the head.

52. The bones of each lower limb are the femur, the patella, the tibia, the fibula, the tarsus, the meta-tarsus, and the phalanges.

53. **The Fe'mur, or thigh-bone,** is the longest bone in the

body. It extends from the deep cavity in the hip-bone to the tibia, at the knee-joint.

54. **The Patel'la, or knee-cap,** is a chestnut-shaped bone, placed in front of the knee-joint. At the upper edge, it is attached to some of the muscles of the leg by a tendon; while

Fig. 15.

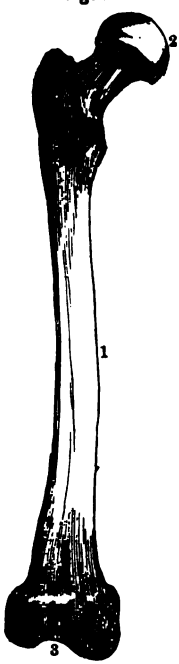


Fig. 16.

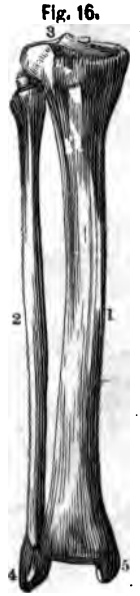


Fig. 15. THE FEMUR. — 1, The shaft; 2, the head of the femur at the pelvis; 3, the end of the femur which articulates at the knee.

Fig. 16. THE BONES OF THE LEG. — 1, The tibia; 2, the fibula; 3, the end which articulates at the knee; 4, the external ankle; 5, the internal ankle.

at the lower edge, it is connected with the tibia by a strong ligament.

55. **The Tib'ia, or shin-bone,** and the **Fib'ula** are the bones of the leg. The tibia joins the femur at the knee; and both the tibia and the fibula join the tarsus at the ankle.

56. **The Tar'sus** is composed of seven bones, which are strongly bound together by ligaments. These form the heel and the instep of the foot.

57. **The Meta-tar'sus** is composed of five bones, forming the middle of the foot. These and the tarsus are arranged

Fig. 17.

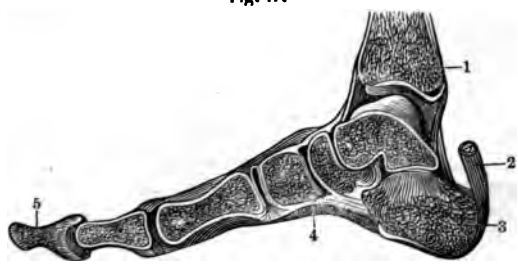


Fig. 17. THE BONES OF THE FOOT, SHOWING ITS ARCHED FORM. — 1, The lower end of the tibia; 2, the tendon of Achilles; 3, the heel; 4, the arch of the foot, supported by the heel and the great toe; 5, one of the phalanges of the great toe.

so as to give the foot an arched form, which acts like a spring, giving elasticity to the step, and serving to break the force of falls and sudden jars.

58. **The Phalan'ges** are the three bones in each of the smaller toes, and the two bones in the great toe.

QUESTIONS.

SECTION II.

1. What is remarked of the bones?
2. What is said of the number of bones?
3. How are the bones classified?
4. Describe the long bones.
5. What is a process? A foramen?
6. What is the color of the bones in and out of the body? What is remarked of their elasticity?
7. What is said of the weight and composition of the bones?

8. What are produced from burning the bones?
9. What is the effect of steeping the bones in acid?
10. What is the difference between the exterior and the interior layer of the bones?
11. What is the difference between the shaft and the extremities of the long bones? What is said of the marrow?
12. What is said of the layers in the broad bones? In the short bones?
13. What is remarked of the compact substance? Of the spongy substance?
14. Describe the periosteum. The endosteum.
15. How is cartilage changed into bone? At what age is ossification completed?
16. How do the different classes of bones grow?
17. What change is always taking place in the bones?
18. How are the bones of the head divided?
19. Describe the bones which compose the skull.
20. How are the two layers arranged in the bones of the skull?
21. What is said of the sutures?
22. What of the shape of the skull?
23. How many bones in the face? Describe the single bones of the face.
24. What is said of the bones of the face which are in pairs?
25. What is remarked of the bones in each ear?
26. How are the bones of the trunk separated?
27. Of what is the spinal column composed? Describe the vertebræ.
28. Name the three classes of vertebræ.
29. Describe the cervical vertebræ.
30. The dorsal vertebræ.
31. The lumbar vertebræ.
32. The intervertebral ligament.
33. The yellow ligament.
34. The anterior and the posterior vertebral ligaments.
35. Describe the ribs.
36. Describe the sternum.
37. Describe the thorax.
38. Describe the pelvis.
39. Describe the sacrum.
40. Describe the coccyx.
41. Describe the hip-bones.
42. What is said of the upper extremities?
43. Describe the clavicle.
44. Describe the scapula.
45. Describe the humerus.
46. Describe the ulna.
47. Describe the radius.

56. **The Tar'sus** is composed of seven bones, which are strongly bound together by ligaments. These form the heel and the instep of the foot.

57. **The Meta-tar'sus** is composed of five bones, forming the middle of the foot. These and the tarsus are arranged

Fig. 17.

Fig. 17. THE BONES OF THE FOOT, SHOWING ITS ARCHED FORM. — 1, The lower end of the tibia; 2, the tendon of Achilles; 3, the heel; 4, the arch of the foot, supported by the heel and the great toe; 5, one of the phalanges of the great toe.

so as to give the foot an arched form, which acts like a spring, giving elasticity to the step, and serving to break the force of falls and sudden jars.

58. **The Phalan'ges** are the three bones in each of the smaller toes, and the two bones in the great toe.

QUESTIONS.

SECTION II.

1. What is remarked of the bones?
2. What is said of the number of bones?
3. How are the bones classified?
4. Describe the long bones.
5. What is a process? A foramen?
6. What is the color of the bones in and out of the body? What is remarked of their elasticity?
7. What is said of the weight and composition of the bones?

8. What are produced from burning the bones?
9. What is the effect of steeping the bones in acid?
10. What is the difference between the exterior and the interior layer of the bones?
11. What is the difference between the shaft and the extremities of the long bones? What is said of the marrow?
12. What is said of the layers in the broad bones? In the short bones?
13. What is remarked of the compact substance? Of the spongy substance?
14. Describe the periosteum. The endosteum.
15. How is cartilage changed into bone? At what age is ossification completed?
16. How do the different classes of bones grow?
17. What change is always taking place in the bones?
18. How are the bones of the head divided?
19. Describe the bones which compose the skull.
20. How are the two layers arranged in the bones of the skull?
21. What is said of the sutures?
22. What of the shape of the skull?
23. How many bones in the face? Describe the single bones of the face.
24. What is said of the bones of the face which are in pairs?
25. What is remarked of the bones in each ear?
26. How are the bones of the trunk separated?
27. Of what is the spinal column composed? Describe the vertebræ.
28. Name the three classes of vertebræ.
29. Describe the cervical vertebræ.
30. The dorsal vertebræ.
31. The lumbar vertebræ.
32. The intervertebral ligament.
33. The yellow ligament.
34. The anterior and the posterior vertebral ligaments.
35. Describe the ribs.
36. Describe the sternum.
37. Describe the thorax.
38. Describe the pelvis.
39. Describe the sacrum.
40. Describe the coccyx.
41. Describe the hip-bones.
42. What is said of the upper extremities?
43. Describe the clavicle.
44. Describe the scapula.
45. Describe the humerus.
46. Describe the ulna.
47. Describe the radius.

48. Describe the carpus.
49. Describe the meta-carpus.
50. What are the phalanges of the fingers?
51. What is said of the lower extremities?
52. Name the bones of the lower limbs.
53. Describe the femur.
54. Describe the patella.
55. Describe the tibia.
56. Describe the tarsus.
57. Describe the meta-tarsus.
58. What are the phalanges of the toes?

SECTION III.

PHYSIOLOGY OF THE BONES.

1. **The Bones** are the framework of the body, and serve to preserve its shape. They afford protection to the most important organs; and they furnish places of attachment for the muscles, thus becoming the levers of motion. They are united together, so as to admit of varied movement; yet they furnish examples of wonderful strength, having been adapted to their several offices by Him who moulds all things in infinite wisdom.

2. In the general structure of the bones, we may observe that they are designed for special use. Their exterior is composed of compact substance, and their interior is porous and spongy. **The compact substance** is most abundant in the shafts of the long bones, which are required for strength; in the pelvis, which is required to sustain the weight of the body; and in the skull, which is most exposed to injury.

3. **The spongy substance** increases the bulk of the bones, but not their weight; it also increases the amount of surface where they articulate at the joints, so that they are much less liable to dislocations. This substance helps to break the force of falls and blows, and thus prevents injury. In

animals that creep, or whose bodies remain close to the ground, and are therefore less liable to injury from falls, the bones contain a comparatively small amount of the spongy material; as may be noticed in snakes and in alligators.

4. **The shaft of the long bones is a hollow tube,** and is much stronger than the same weight of bone would be if in a solid rod; for it is a well-known truth, that a hollow column will support a much greater weight than a solid column containing the same amount of material. A familiar example of this principle occurs in the stems or culms of many plants, such as wheat, rye, and corn, which are very light, yet have strength enough to support their ripened fruit, even when waved about in the passing breeze.

Fig. 18.

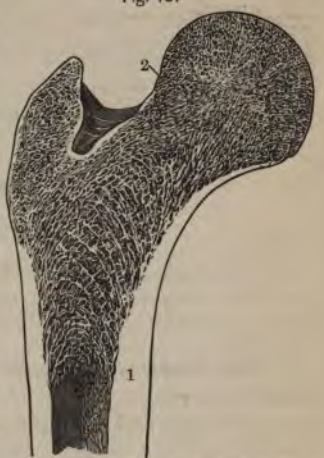


Fig. 18. A SECTION OF A BONE, SHOWING THE COMPACT AND THE SPONGY SUBSTANCE. 1, The compact substance; 2, the porous, or spongy substance.

5. **The human cranium is ovate in form,** and is very similar to the shape of an egg, so that it is well adapted to resist pressure on all sides. The smallest and strongest end is situated in front, where it is most liable to receive injury from external violence. The sutures in it tend to reduce the force of blows; and, considered altogether, it is a bony case exactly suited to protect the delicate brain within.

6. **The spinal column is the back-bone of the body.** It furnishes a support for the head, and a basis of attachment for the ribs, the muscles, and the pelvis, which support and protect all the important organs of respiration, digestion, and circulation. It also provides a canal to protect the spinal cord; it admits of varied movement, backward, forward,

and to either side; and, by its cushions of fibro-cartilage, it helps to secure the brain from the shocks occasioned by walking, running, leaping, or falling.

7. The upper and lower extremities are adapted to the purposes for which they are designed. The upper limbs are for **prehension,** and the hand is so shaped as to facilitate the grasping of any object; but the lower limbs are for **locomotion,** and the bones are so arranged as to give firmness and elasticity to the step.

QUESTIONS.

SECTION III.

1. Mention some of the uses of the bones.
2. What is said of the general structure of the bones? Where is the compact substance most abundant?
3. What is remarked of the spongy substance in the bones?
4. What is said of the shaft of the long bones? Illustrate by a familiar example.
5. What is remarked of the shape and the use of the cranium?
6. What are the uses of the spinal column?
7. To what purposes are the upper and the lower limbs adapted?

SECTION IV.

ANATOMY AND PHYSIOLOGY OF THE JOINTS.

1. **The joints, or articulations,** are formed by the union or joining together of two or more bones. Some joints are immovable, while others possess more or less motion. Those between the bones of the skull are **immovable,** and are called *sutures.* When these sutures are toothed, so as to dovetail into each other, as between the frontal and parietal bones, they are called **Ser'rated sutures;** but when the edges are bevelled, so as to overlap each other, as between the

parietal and occipital bones, they are called **Squa'mous sutures.**

2. **The movable joints** vary in their kind of motion. Some have a *hinge-like* motion, as in the elbow and the knee-joints, and in the joints of the fingers and toes. The wrist and the ankle-joints have the hinge-like motion, together with a lateral motion, or a motion to either side.

3. Some joints have a *rotary* motion, as between the two vertebræ next to the skull, by which the head is rotated; and also in the articulations of the bones of the forearm, by which the hands are rotated.

4. The joints which admit of the fullest motion, are the *ball and socket joints*, in which the head of one bone fits into a cup-shaped cavity of another bone, as in the shoulder and the hip-joints. They admit of free movement in almost every direction.

5. The two movements in the hinge-joints are called flexion and extension. **Flexion** is the movement of the shaft of one bone toward the other bone with which it is attached, as in the flexion of the forearm forward upon the arm, and the leg backward upon the thigh. **Extension** is the movement opposite of flexion. It brings the limb back to an extended or straightened position.

6. The structures which enter into the composition of the joints, are bones, cartilages, fibro-cartilages, ligaments, and synovial membranes. All of these, except the ligaments, have been described.

7. **The ligaments** surrounding the joints are of two kinds: the capsular and the band-like ligaments. They are composed of fibrous tissue, and are very flexible. **The capsular ligaments** are joined to the edges of the articular surfaces of the bones forming the joints, so as to form cylindrical sacs. **The band-like ligaments** are the lateral ligaments which help to strengthen the joints.

8. *At the movable joints*, the ends of the bones are covered with fibro-cartilage, which gives to them a very smooth,

polished surface, and lessens in a great degree the amount of friction. At each joint there is a capsular ligament which forms a cylindrical sac, like a bag that is open at both ends. These ends are joined to the edges of the articular surfaces of the bones; thus making a closed sac around the joint. External to the capsular ligament, are the band-like, or lateral ligaments, which are attached to the bones forming the joints, so as to hold them securely together. The internal surface of the capsular ligament is lined with the synovial membrane, which secretes an oily fluid, called **Syno'via,** to lubricate, and still further reduce the friction in the joint.

9. **The lower jaw** is attached to the temporal bone, forming a hinge joint, which admits of a downward and upward movement, as in opening and closing the mouth; and a side, or lateral movement, as in mastication or chewing.

10. The forward and backward *movements of the head* are hinge-like, and occur between the occipital bone and the atlas; but the rotary motion of the head is between the atlas and the axis, or the first two vertebræ.

11. **The shoulder-joint** is a ball and socket joint, in which the head of the humerus moves in the glenoid cavity of the scapula. It is the most movable joint in the body.

12. **The elbow-joint** is a hinge joint; **the wrist-joint** is also hinge-like, but it may be moved from side to side, as well as be rotated, thus giving much freedom to the movements of the hand. The fingers and thumb have a hinge motion, which admirably adapts them for grasping objects.

13. **The hip-joint,** where the head of the femur moves in the acetabulum, is the best instance of a ball and socket joint, and is the strongest joint in the body. **The knee-joint** is the largest of the joints, and both it and **the ankle-joint** are hinge-like in their movements.

14. In no part of the human frame is the wisdom of the Creator more clearly exhibited, than in the admirable construction of the movable joints, and their adaptation to the

varied movements required of them. A person may walk thirty miles a day, requiring not less than forty thousand steps, yet the joints of the lower limbs permit this amount of motion without injury; and thousands of movements may be made daily by the hands and arms, without even feeling weary!

QUESTIONS.

SECTION IV.

1. How are the joints formed? What is said of the immovable joints?
2. What of the joints with a hinge-like motion?
3. What of those having a rotary motion?
4. What of the ball and socket joints?
5. Define the two movements, flexion and extension.
6. Of what structures are the joints composed?
7. Describe the ligaments surrounding the joints.
8. Describe fully the structure of a movable joint.
9. Describe the movements of the lower jaw.
10. The movements of the head.
11. The movements of the shoulder-joint.
12. The elbow, the wrist, and the finger-joints.
13. The hip, the knee, and the ankle-joints.
14. What is remarked of the movable joints?

SECTION V.

ANATOMY OF THE MUSCLES.

1. **The Muscles** are the fleshy or lean parts of the body. They surround the skeleton and contribute much towards producing the shape of the human being. The muscles usually consist of a tendon at each end, and a middle or fleshy part, which is called the belly. The fleshy part of the muscle is endowed with the power of **contractility**, and is, therefore, the agent of motion; while the tendons have no such power, and are entirely passive.

2. The muscles are attached by their tendons to the bones; and the points of attachment of a muscle, are called its origin and its insertion. **The origin** is the point that is least movable, and is generally the one nearest to the spinal column; while the **insertion** is the point that is most movable, and is generally the one farthest from the spinal column.

3. **The tendons, or sinews,** are bundles of yellowish or bluish-white fibrous tissue, striated lengthwise, and glistening. They are very strong and very flexible, but are entirely inelastic. Most of the tendons are gradually narrowed from the fleshy part of the muscles to the points of attachment, and thus form flattened or cylindrical cords; but others continue of the same width to their origin or insertion, and these are called **aponeuro'ses.**

4. Each muscle is invested with a fibrous sheath, called **fas'cia,** which holds its fibrils together; and each group of muscles is enveloped in a still stronger and firmer fibrous sheath, also called fascia, which holds the muscles together.

5. The flattened or cylindrical tendons are often confined in grooves in the bones, or are kept in their places by passing beneath ligaments, as in the tendons of the fingers, which pass beneath the ligament at the wrist and the ligaments of the phalanges. When the tendons pass beneath the ligaments, or over the bones, they are more or less invested with a serous membrane, called **synovial bursæ,** which reduces the friction at those points.

6. The muscles are supplied with blood-vessels, which run between the muscular fibres and parallel to them. These blood-vessels give to the muscles their red appearance, which is characteristic of the flesh of all warm-blooded animals. The muscles are abundantly supplied with nerves, although they are only moderately sensitive. The tendons contain but few blood-vessels or nerves; hence their white color and their insensibility.

7. **The names of the muscles** are mostly derived from their shape, their position, their attachments, or their physiological

Fig. 19.

Fig. 19. A View of the Principal Muscles of the Front of the Body.—1, The great pectoral muscle; 2, the biceps; 3, the triceps; 4, the deltoid; 5, the internal oblique muscle; 6, the gluteal muscles; 7, the rectus muscle; 8, the sartorius muscle; 9, the internal vastus muscle; 10, the soleus muscle; 11, the tendon of Achilles; *12, the occipito-frontal muscle.*

action. Some of them are spindle-shaped, terminating at each extremity in a flattened tendon; some are triangular, and are called radiated muscles; some have their fibres arranged like one side of a feather, and are, therefore, called penniform muscles; some are arranged like an entire feather, and are called bi-penniform muscles; and others run in a circular direction, as the muscle around the mouth, and are called orbicular, or sphincter muscles.

8. There are more than **five hundred muscles** in the human body. These are all arranged in pairs, with the exception of twelve, which are single. The muscles of each pair act in opposition to each other; when one contracts the other relaxes, and thus motion is produced.

9. Some muscles are called **flexors**, because they act so as to bend the limbs at the joints, as in the shutting of the hand, and in the bending of the arm at the elbow; and some are called **extensors**, because they extend or straighten the limbs, as when the hand is opened, or the arm straightened.

10. The muscles may be divided into two classes, called the *voluntary* and the *involuntary* muscles. **The voluntary** muscles act under the control of the will, and move only as the individual wishes them to move. They embrace nearly all the muscles in the body. **The involuntary** muscles act without the aid of the will. This class embraces the heart, the stomach, the intestines, and other organs which continue their movements during life, without the control of the person. The action of some of the involuntary muscles admit of a limited influence from the will, as in respiration; but their regular movements are always independent of the mind.

Muscles of the Head and Neck.

11. **The Occip'ito-front'al** muscle elevates the eyebrows.

12. **The Pal'pebral Orbic'ular** muscle closes the eyelids, and performs the act of winking.

13. **The O'ral Orbic'ular** muscle closes the mouth, and

Fig. 20.

Fig. 20. A View of the Principal Muscles of the Back of the Body.—1, The occipito-frontal muscle; 2, the trapezius; 3, the deltoid; 4, the latissimus dorsi muscle; 5, the triceps extensor muscle; 6, the middle gluteal muscle; 7, the great gluteal muscle; 8, the biceps flexor of the leg; 9, the soleus muscle; 10, the tendon of Achilles.

produces the various changes made in the shape of the aperture, by the movements of the lips.

14. **The Zygomat'ic** muscles elevate the angles of the mouth, as in smiling.

15. **The Tem'poral and Mas'seter** muscles produce the movements in the lower jaw.

16. **The Sterno-mas'toid** muscle, when both sides contract, draws the head downward, but when one side alone contracts, the face is turned toward the opposite side.

Muscles of the Front Part of the Trunk.

17. **The Great Pec'toral** muscle draws the arm downward and forward across the chest.

18. **The Great Ser'rated** muscle draws the shoulder forward, and aids in respiration by elevating the ribs.

19. **The External Oblique'** and the **Straight Abdom'inal** muscle occupy the sides and front of the abdomen. They support and compress the abdominal organs, and depress the ribs in respiration. When the muscles of one side only act, the body is turned to that side.

Muscles of the Back Part of the Trunk.

20. **The Trape'zius** muscle draws the shoulder back toward the spine, and the head backward, or to one side.

21. **The Latis'simus** muscle draws the humerus downward and backward, and, with the pectoral muscles, is the chief agent in climbing.

22. **The Rhom'boid** muscle draws the scapula upward and backward.

23. **The Supe'rior Ser'rated** muscle aids in elevating the ribs, and the **Infe'rior Ser'rated** muscle in depressing them; thus both assist in respiration.

Muscles of the Upper Extremities.

24. **The Del'toid** muscle raises the arm to a horizontal position.

25. **The Bi'ceps and Brach'ial** muscles flex or bend the forearm on the arm.

26. **The Tri'ceps** muscle extends or straightens the forearm on the arm.

27. **The Ra'dio-car'pal Flex'or** bends the hand on the wrist; and the **Ul'no-car'pal Flexor** bends the hand in the direction of the ulna.

28. **The Ra'dio-car'pal Exten'sor** extends the wrist on the forearm.

29. **The Flex'ors** in front of the fingers, and the **Exten'sors** on the back of the fingers, close and open the hand.

Muscles of the Lower Extremities.

30. **The Glu'teal** muscles rotate the thighs outwardly, and retain the body in an erect position.

31. **The Sarto'rius** muscle flexes the leg upon the thigh; and, with the aid of the *Grac'ilis* muscle, draws one leg across the other.

32. **The Quad'riceps Exten'sor,** composed of the Rec'tus, External Vast'us, Internal Vast'us, and the Crural'is, extends the leg upon the thigh.

33. **The Pectine'al and Adduc'tor** muscles bend the thigh on the pelvis, and rotate it outwardly.

34. **The Bi'ceps Flex'or** muscle turns the leg outward, and flexes it on the thigh.

35. **The Exten'sors of the toes** bend the foot on the leg, but extend the toes.

36. **The Ante'rior Perone'al** and the **Tib'ial** muscles bend the foot; and they are the antagonists of the *Long and Short Perone'al* muscles, which extend the foot.

37. **The Gastrochne'mius and Sole'us** muscles extend the foot on the leg, and raise the body upon the toes in walking, in jumping, and in other active movements.

38. The tendons of the Gastrochne'mius and Sole'us muscles unite and form the tendon of **Achil'les,** which is inserted into the bone of the heel.

39. **The Di'aphragm** is a muscular partition separating the abdomen from the thorax. Three important orifices exist in it, which are for the passage of the œsophagus, the aorta, and the inferior cava. The diaphragm is a very important muscle; for it aids in respiration, coughing, yawning, sneezing, sighing, singing, vomiting, hiccoughing, sobbing, and crying.

QUESTIONS.

SECTION V.

1. Describe the muscles. With what are they endowed?
2. How are the muscles attached to the bones? What is meant by the terms origin and insertion?
3. Describe the tendons.
4. Describe the fascia.
5. How are the tendons kept in place? What are synovial bursæ?
6. What is said of the blood-vessels and nerves in the muscles?
7. From what are the names of the muscles derived? Define the different kinds of muscles.
8. How many muscles in the body? How are they arranged, and how do they act?
9. What are flexor muscles? Extensor muscles?
10. What is said of the voluntary muscles? The involuntary muscles?
11. What is the use of the occipito-frontal muscle? 12. The palpebral orbicular? 13. The oral orbicular? 14. The zygomatic? 15. The temporal and masseter? 16. The sterno-mastoid? 17. The great pectoral? 18. The great serrated? 19. The external oblique? 20. The trapezius? 21. The latissimus? 22. The rhomboid? 23. The serrated? 24. The deltoid? 25. The biceps and brachial? 26. The triceps? 27. The radio-carpal flexor? 28. The radio-carpal extensor? 29. The flexors and extensors of the fingers? 30. The gluteal? 31. The sartorius? 32. The quadriceps extensor? 33. The pectineal and adductor? 34. The biceps flexor? 35. The extensors of the toes? 36. The peroneal and tibial? 37. The gastrochnemius and soleus muscles? 38. The tendon of Achilles? 39. The diaphragm?

SECTION VI.

PHYSIOLOGY OF THE MUSCLES.

1. **The Muscles** constitute by far the **larger** portion of the human body, and give to its exterior both symmetry of form and beauty. They are its principal organs of motion, and their various shapes and sizes depend upon the offices which they are required to perform. While the bones are a support to the muscular system, providing it with the means of fulfilling its functions, the muscles cover the bones, and, by their soft and yielding nature, break the force of blows and falls, and thus protect the framework from injury.

2. *The muscles have the power of contraction* and relaxation,* by which they are shortened and lengthened. Upon this power depend all the movements of the body, whether in the employments or the enjoyments of life; and, wherever any movement is required, muscular fibres are there to produce it. This property of the muscles is ordinarily excited by impressions received from the nervous system; but it may be excited by a change of the temperature of the air, by electricity, by chemical agencies, and by mechanical irritation.

3. When a muscle contracts, its extremities, and the organs to which they are attached, are brought nearer together; hence, there is a change in the position of the bones which furnish the principal points of attachment for the muscles. The tendons are without the power of contraction; therefore, all movement depends upon the muscular fibres alone.

---

* The rapidity with which the muscles can contract and relax, may be understood by reflecting upon the velocity of movement of certain creatures. The hawk and the pigeon move at the rate of one hundred and fifty miles per hour; the swiftest race-horse, Eclipse, fifty-six miles per hour; the swiftest fish, salmon, twenty-five miles per hour; and man, when running, moves about ten miles per hour. If Eclipse cleared fifteen feet at each bound, he must have made over three hundred leaps in a minute, requiring over three hundred alternate contractions and relaxations of the flexor and extensor muscles of his limbs.

4. When a muscle contracts, its body or fleshy part is decreased in length, but it is increased in breadth and thickness, becoming larger and firmer. When a muscle relaxes, it is increased in length but becomes smaller and softer. By grasping the arm between the shoulder and the elbow, these changes may be observed. When the arm is bent, the flexor muscle contracts and becomes larger and firmer, while the extensor relaxes and becomes smaller and softer; but when the arm is extended, the flexor muscle is relaxed and the extensor contracted.

5. *The flexor and extensor muscles are antagonistic to each other*, and are placed on the opposite sides of the joints, so as to produce the two movements of flexion and extension. As the muscle on one side contracts, so must the muscle on the other side relax in a corresponding degree; thus, both

Fig. 21.

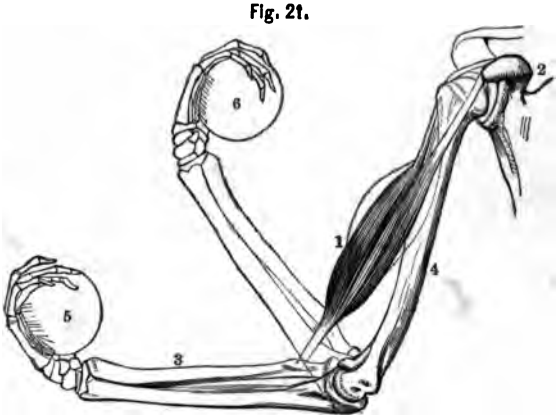


Fig. 21. A VIEW OF THE ELBOW-JOINT.—1, The flexor muscle; 2, the scapula; 3, the bones of the forearm; 4, the humerus; when the muscle contracts, the hand is moved from 5 to 6.

muscles are under the influence of the mind at the same moment, although their movements are directly opposite to each other.

6. *The manner by which muscles produce these movements, may be illustrated by Fig.* 21, *which represents the elbow-joint.*

The tendon at one end of the flexor muscle has its origin in the scapula, while the tendon at the other end is inserted in one of the bones of the forearm. When the muscle contracts, the ends of it and the bones to which they are attached, are brought nearer to each other. But the scapula is bound to the thorax, so as not to be moved; hence, all the motion is at the other end of the muscle, so that the forearm and hand are drawn towards the shoulder.

7. *By the power of the will over the voluntary muscles, we regulate all the movements and positions of the body,* as in sitting and standing; in walking, running, and leaping; in lifting weights; and in all the manifold movements of the upper limbs. This power enables us to engage in the duties of life, to take part in its pastimes, to provide for the sustenance of our bodies, and to exercise our vocal organs in conversation with our friends.

8. *The voluntary muscles may be educated in various ways.* This is done whenever we learn to perform anything requiring their movements. The result of this education may be witnessed in the graceful movements of the skater, the exact movements of the musician, and the skilful movements of the surgeon. The *involuntary muscles* enter into the movements of the lungs, in respiration; of the heart and blood-vessels, in the circulation; and of the stomach and intestines, in digestion.

9. It is a wise provision made by our Creator, that the respiratory muscles should act either with or without the aid of the will. When we are asleep, or when our minds are engaged in the duties or the pastimes of life, the respiration continues without our attention; but when we desire to swallow either food or drink, or to listen attentively to any noise, we suspend our breathing for a short period by the effort of the will.

10. *The size and strength of the muscles may vary very much* in the same person at different periods of life, depending in a great measure upon their use. Exercise tends to increa-

them in size and strength, while want of exercise permits them to become soft and weak. The power of endurance in an individual depends upon the development and training of the muscles, the size of the nerves, and the size and activity of the brain.

11. *When muscles are kept steadily contracted they become tired, and for a time lose their power of contractility;* but this is regained again by rest. The time required for the muscles to become tired depends upon their tone and the power exerted by their contraction. When the muscles are weak, or when great effort is made, exhaustion soon follows; but when the muscles are strong and the effort moderate, they will remain contracted for a much longer period.

12. *The tendons at the ends of the muscles possess no power of contractility.* They serve to attach the muscles to the bones; and in their small size, their great strength, and their skilful arrangement, they are admirably adapted to that purpose. They convey power where the more bulky muscle would prove inconvenient, as in the hands and the feet. Suppose the fleshy muscular fibres be substituted for the small tendons in the human hand, what a bulky organ the hand would be; and if substituted for the tendons in the foot, what a monstrous foot they would make! The beauty of both hands and feet would be destroyed, and they would be rendered entirely unfit for many of the purposes of life.

13. With what nice mechanical skill has the Infinite mind adjusted the bones, the joints, the muscles, and the tendons of the body! All are arranged so as to produce entire unity and harmony of action in their movements, whether they be the large and powerful Gastrochnemii, in the calf of the leg; the delicate muscles of the eye and the ear; or those of the vocal organs, by which sounds wonderfully sweet and harmonious are made. Every part of the human body bears the impress of the Creator, and when we study it aright, we will find much to lead our thoughts from nature up to nature's God!

QUESTIONS.

SECTION VI.

1. What do the muscles constitute? What is remarked of their use?
2. Of what use is the power of contraction and relaxation? How is this power excited?
3. How does the contraction of muscles affect the bones? Upon what does all movement depend?
4. How is the fleshy part of a muscle affected by contraction? How may these changes be observed?
5. Describe the action of the flexor and the extensor muscles.
6. Explain how movement is produced in the elbow-joint.
7. What use do we make of the voluntary muscles?
8. What is said of educating the voluntary muscles? What movements are produced by the involuntary muscles?
9. How do the respiratory muscles act? Of what use is this?
10. What is remarked of the size and strength of the muscles?
11. What is said of the loss of contractility in the muscles?
12. Of what use are the tendons at the ends of the muscles? What about their use in the hands and feet?
13. What is remarked of the arrangement of the bones, joints, muscles, and tendons of the body?

CHAPTER III.—Nutritive Apparatus.

SECTION I.

THE MEMBRANES OF THE BODY.

1. **The membranes** of the body are divided into the *serous* and the *mucous* membranes. They both possess the same anatomical elements; which are a cellular layer, a basement membrane, and a fibrous layer.

2. **The Cel'lular Layer** occupies the free surface of the serous and mucous membranes, and is called **Epithe'lium.** From the difference in form, the epithelium is divided into several varieties; as the squamous, the pavement, the columnar, and the ciliated epithelium.

3. **The Squa'mous Epithe'lium** consists of many layers of broad, thin scales. It is found in the mucous membrane of the mouth and nose. **The Pave'ment Epithe'lium** consists of from one to four layers of flat cells, which are hexagonal, and are arranged like the blocks of a pavement. It is found in the serous membranes.

4. **The Colum'nar Epithe'lium** consists of a single layer of hexagonal columnar cells, pointed at one end. It is found in the mucous membrane of the stomach and intestines. **The Cil'iated Epithe'lium** is similar to the columnar, except that cilia, or fine filaments, arranged somewhat like the eyelashes, are attached to the free extremity of the cells. These

have the power of moving backward and forward, and by this means convey liquids from one place to another. It is found in the mucous membranes of the trachea and the bronchial tubes, the upper part of the nose and pharynx, and in the ear.

Fig. 22.

Fig. 22. The Ciliated Epithelium of the Bronchial Mucous Membrane. 1, The columnar cells; 2, the cilia; 3, the nuclei; 4, the young cells; 5, the basement membrane; 6, the fibrous layer.

5. **The Base'ment Membrane** is a thin, homogeneous layer, beneath and in contact with the cellular layer. It is so thin as to be difficult of detection in some cases. Beneath this membrane is the fibrous layer, composed of fibrous and elastic tissue. The blood-vessels, lymphatics, and nerves, are found in the fibrous layer, but they never penetrate the cellular layer or the basement membrane.

6. **The Se'rous Membranes** line all the cavities of the body, which are without any external communication, and are, therefore, *closed sacs*. The outer surface of serous membranes is attached to other organs by connective tissue; but the inner surface is smooth and shining, and secretes a serous liquid, called **serum**, which lubricates it.

7. The serous membranes are thin and transparent, moderately strong, elastic, and extensible. They consist of one or more layers of pavement epithelium, a thin basement membrane, and a layer of fibrous tissue. They contain only a few blood-vessels; but they have numerous lymphatics and nerves, although they are without sensibility when in a state of health. **The serum** which they secrete is composed of water, albumen, chloride of sodium, phosphate of lime, and phosphate of soda.

8. The principal serous membranes are the two pleura, investing the lungs; the pericardium, surrounding the heart; the peritoneum, lining the cavity of the abdomen; the arachnoid membrane of the brain; the synovial membrane

of the joints; and the lining membrane of the heart and blood-vessels.

9. **Syno'vial Membrane** is a form of serous membrane lining the interior of the joints, but not covering the articular cartilages. It secretes a fluid, called **synovia,** which is more viscid than that of other serous membranes. At the margin of the joints, it forms one or more folds, called synovial fringes, from which much of the synovia is secreted.

10. **Mu'cous Membranes** line all the cavities and passages of the body which have an external communication, and, therefore, *never form closed sacs.* They are all continuous with the skin, and with each other; and their free surface is bathed with a viscid liquid, or secretion, called **mucus.**

11. The mucous membranes are less transparent than serous membranes; but they are supplied with more blood-vessels, lymphatics, and nerves. They vary from a white color to a dark-red, depending upon the amount of blood in them. They consist of an epithelium, basement membrane, and a fibrous layer, the latter of which is abundantly supplied with minute glands. **The mucus** secreted is a clear, colorless, transparent, viscid liquid, composed of water, alkaline salts, and the proximate principle, called *mucosin.*

12. The principal mucous membranes are those which line the front of the eye, the deep parts of the ear, the nose, the trachea and the bronchial tubes in the lungs, the ducts leading from various glands, and the whole alimentary canal.

QUESTIONS.

SECTION I.

1. How are the membranes of the body divided? What do they possess?

2. Describe the cellular layer. Mention its varieties.

3. Of what does the squamous epithelium consist? The pavement epithelium?

4. The columnar epithelium? The ciliated epithelium?
5. Describe the basement membrane.
6. Where are serous membranes found? What is said of their surfaces?
7. Describe the serous membranes, and their secretion.
8. Name the principal serous membranes.
9. Describe the synovial membrane.
10. Where are mucous membranes found? What is said of their free surface?
11. Describe the mucous membranes, and their secretion.
12. Name the principal mucous membranes.

SECTION II.

THE GLANDS OF THE BODY.

1. **A gland** is an organ which secretes and pours forth a liquid from one or more ducts, or orifices, opening on the surface of the skin or mucous membrane. This liquid is called a **secretion,** and has various names depending upon its source; thus, it is called mucus, from mucous membrane; saliva, from the salivary glands; and bile, from the liver. When this secretion is rejected from the body as useless, it is then called an **excretion,** as the perspiration from the skin.

2. The glands consist of a tube, or a series of tubes, which are composed of an epithelium, a basement membrane, and a fibrous layer; the latter containing the blood-vessels from which each gland elaborates its secretion. It also contains lymphatic vessels and nerves.

3. The simplest form of a gland is one straight tube closed at one end, and opening at the other end upon the free surface of the mucous membrane, as in the glands of the small intestine. This tube may be dilated at the bottom, as in the sebaceous glands of the skin; it may be divided at the bottom into two or more parts, as in the gastric glands; it may be rendered complex by becoming convoluted, as in the

sweat glands; it may become branched and rendered more complex by becoming convoluted, as in the kidneys; the terminal branches may be dilated into vesicles, resembling a bunch of grapes, as in the salivary glands; or the branching tubes may form a network, as in the liver.

4. The principal glands may be classified as the tubular, the follicular, the convoluted, the racemose, and the reticular glands.

5. **The Tu'bular glands** are usually short and uniform in diameter throughout. They are imbedded in the fibrous layer of the mucous membranes of the nose, the stomach, the small, and the large intestine.

Fig. 23.

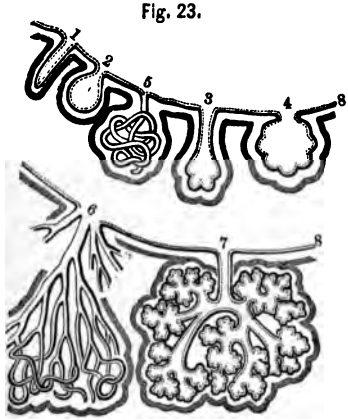


Fig. 23. A View of the Different Kinds of Glands.—1, Tubular gland; 2, 3, and 4, follicular glands; 5 and 6, convoluted glands; 7, racemose gland; 8, the surface of the mucous membranes.

6. **The Follic'ular glands** are tubular glands, more or less divided at the bottom. These divisions open into a common canal or duct, through which the secretion of the gland is conveyed to the surface of the mucous membranes. The sebaceous glands of the skin, the glands of the root of the tongue, the tonsils, the soft palate, and the pharynx, are follicular glands.

7. **The Con'voluted glands** are tubular glands rolled into a convoluted mass at one end. They present two forms: the simple form, as in the sweat glands; and the compound form, as in the kidneys.

8. **The Rac'emose glands** are rendered complex by being branched, and in appearance resemble a cluster of grapes. The tubes of the racemose glands collect into one or more principal ducts, which have fibrous walls and are lined with

mucous membrane. The principal racemose glands are the lachrymal, lingual, salivary, duodenal, pancreas, tracheal, and bronchial.

9. **The only Retic'ular gland is the liver.** It is divided into several lobes, and these are subdivided into smaller lobes or lobules. Ducts from these lobules finally converge into the principal ducts, which have fibrous walls and are lined with mucous membrane, the same as the racemose glands.

QUESTIONS.

SECTION II.

1. What is a gland? What is said of the glandular secretions?
2. Describe the structure of the glands.
3. What is the simplest form of a gland? How may this form be varied?
4. How may the principal glands be classified?
5. Describe the tubular glands.
6. The follicular glands.
7. The convoluted glands.
8. The racemose glands.
9. The reticular gland.

SECTION III.

ANATOMY OF THE DIGESTIVE SYSTEM.

1. **The Digestive Organs** include the mouth, the palate, the tonsils, the tongue, the salivary glands, the teeth, the pharynx, the œsophagus, the stomach, the small intestine, the large intestine, the pancreas, the liver, and the spleen. The canal formed by the mouth, pharynx, œsophagus, stomach, and intestines, is called the alimentary canal.

2. **The Mouth** is the space bounded by the lips in front,

the pharynx behind, the roof or palate above, the floor below, and the cheek on each side. The roof of the mouth is inclosed by the alve'olar arch and the upper teeth; the floor of the mouth is inclosed by the alveolar arch and the lower teeth, and has the tongue resting upon it. The mouth, excepting the teeth, is everywhere lined with a highly vascular mucous membrane, having a squamous epithelium.

3. **The Pal'ate** is composed of two parts; called the hard palate, and the soft palate. *The hard palate* covers the bones of the roof of the mouth; but the *soft palate* is back of the hard palate, and is freely movable. Both palates contain numerous small racemose glands. A small, tongue-like body, called the **U'vula,** hangs from the middle of the soft palate.

4. **The Ton'sils** are two glands, one on each side of the throat. They are about the size and shape of an almond kernel, and in popular language are often called *almonds.* They are compound follicular glands, and secrete *mucus,* which lubricates the food in its passage to the stomach.

5. **The Tongue** * is a muscular organ resting on the floor of the mouth. It has much freedom of movement, and aids in the mastication and swallowing of the food. It contains both racemose and follicular glands which probably secrete *mucus.*

6. **The Sal'ivary glands** consist of three glands on each side of the mouth; named the parotid gland, the submaxillary gland, and the sublingual gland. They all secrete a liquid, called *saliva.*

7. **The Parot'id gland,** which is much the largest of the salivary glands, is situated in front of the external ear and behind the angle of the lower jaw. The parotid duct from this gland, which opens into the mouth opposite the second molar tooth of the upper jaw, is about two inches long, and in diameter is one-half the size of a goose-quill. In the disease called *mumps* this gland becomes enlarged.

* A fuller description of the tongue will be found in the Sections which treat of the Organs of Special Sense.

8. **The Submax'illary gland** is situated just within the angle of the lower jaw, and communicates with the mouth by one slender duct, two inches long. **The Sublin'gual gland** is situated on the floor of the mouth beneath the side of the tongue, and communicates with the mouth by six or eight small ducts.

9. **The Teeth** are firmly fixed in the alveolar arches of the upper and the lower jaw-bone by means of bony sockets. The exposed portion of a tooth is called its *crown or body;* the portion inserted into the socket of the jaw is the *fang or root;* and the part clasped by the gums is the *neck.*

Fig. 24.

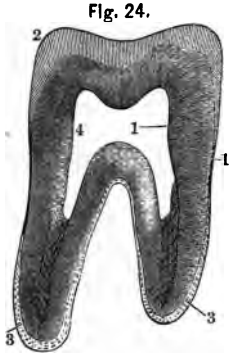


Fig. 24. A Section of a Tooth. — 1, The dentine; 2, the enamel; 3, the cement; 4, the pulp cavity.

10. In the interior of each tooth is a small cavity, filled with a soft substance, named *pulp*, and containing both nerves and blood-vessels. The teeth are composed of three substances: **Den'tine or ivory,** resembling dense bone and forming the principal bulk of the tooth; **Enam'el** (the hardest organic substance known), covering the crown of the tooth; and **Cement',** a thin layer of bone covering the fang of the tooth, thinnest near the enamel and thickest towards the end of the fang.

11. In the grinding-teeth of herbivorous animals, as the horse and the ox, these three substances are alternately arranged so that as the teeth are worn the triturating surfaces become uneven and thus facilitate the grinding of the food. In carnivorous and in omnivorous animals, as the cat, the dog, and the hog, these substances are arranged in the same manner as in the teeth of the human being.

12. Man, as well as almost all other mammals, is provided with *two sets of teeth;* the first set is called the temporary or milk teeth, and the second set is called the permanent teeth. Reptiles and fishes have numerous sets of teeth, which ceed one another through life.

13. **The temporary, or milk teeth,** are twenty in number. On each side of the upper and of the lower jaw are five teeth; two incisors, one canine, and two molars. These teeth appear in infancy; but they are gradually removed from the fifth to the fourteenth year, and are then succeeded by the permanent teeth, which are both larger and stronger.

14. **The permanent teeth** are thirty-two in number. On

Fig. 25.

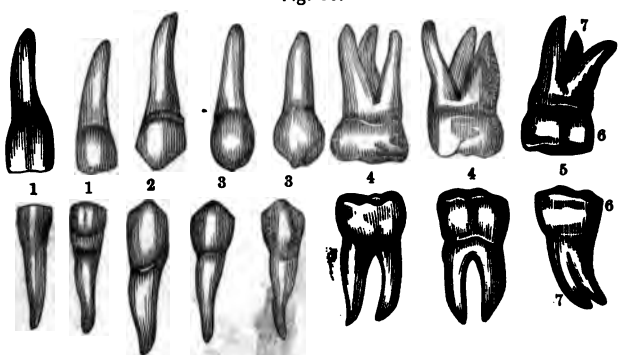


Fig. 25. A View of the Permanent Teeth. — 1, Incisors; 2, canines; 3, bicuspids; 4, molars; 5, wisdom teeth; 6, the crown; 7, the fang, or root.

each side of the upper and of the lower jaw are eight teeth; two incisors, one canine, two bicuspids, and three molars.

15. **The inci'sors** are the front teeth, and are so named, because the crown is wedge-shaped, and is, therefore, adapted to biting or cutting the food. **The canine' teeth** are placed next to the incisors, and have been so named from their great size and strength in the canine, or dog tribe of animals. In the human being, the upper canines are called eye-teeth, and the lower canines are called stomach teeth.

16. **The bicus'pids,** or small grinders, are placed next to the canine teeth. Their grinding surface consists of two points, with a rough groove between them. **The mo'lars,** or grinders, have each a large crown, and a grinding surface, which has four points separated by grooves. The last molar

tooth, on each side, usually appears about the twentieth year, and is called the **wisdom tooth.**

17. The incisors, cuspids, and bicuspids, have only one root each; while the molars of the lower jaw have two roots, and those of the upper jaw have three roots each.

18. **The Phar'ynx, or throat,** is the funnel-like cavity, about four inches long, extending from the back part of the mouth to the œsophagus, which is on a level with the fifth cervical vertebra. The larynx opens into the pharynx from below, and the nasal cavities open into it from above. The walls of the pharynx consist of a fibrous layer externally; a middle layer, which is muscular; and an internal layer of mucous membrane, which is continuous with that of all the cavities opening into it. The glands of the pharynx are both racemose and follicular.

19. **The Œsoph'agus, or gullet,** is a muscular tube extending from the pharynx to the stomach. It is about nine inches long, and is nearly an inch in diameter. Its course through the neck and thorax, is in front of the vertebræ, but behind the trachea and the heart. The walls of the œsophagus consist of an external fibrous layer; a middle layer which is muscular; and an internal layer of mucous membrane, which is much paler than that of the mouth or pharynx. It contains a few scattered racemose glands.

20. **The Abdo'men** is the large cavity in the body, extending from the diaphragm to the pelvis. Within it are found the stomach, the intestines, the liver, the spleen, the pancreas, and the kidneys. These are called the *abdominal viscera.* A serous membrane, called the **Peritone'um,** lines the inner walls of the abdomen, and from them is reflected upon the abdominal viscera, so as to form a closed sac. A portion of the peritoneum is folded over the intestines, like a broad apron. This is called the **Omen'tum,** and in fat persons contains large accumulations of fat.

21. **The Stom'ach** is a large pouch, extending from the œsophagus to the small intestine. It is situated in the left

side of the abdomen, just beneath the diaphragm. The stomach is from nine to twelve inches long, and from four to five inches in diameter, at the largest part. It will hold from one to two quarts; but it may be distended, so as to become still larger. The opening from the œsophagus into the stomach is called the *car'diac orifice;* and the opening from the stomach into the small intestine is called the *pylor'ic orifice.*

Fig. 26.

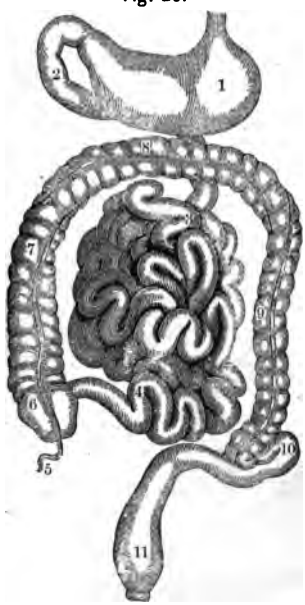


Fig. 26. THE STOMACH AND INTESTINES. — 1, The stomach; 2, the duodenum; 3, the jejunum; 4, the ileum; 5, the vermiform appendage; 6, the cæcum; 7, the ascending colon; 8, the transverse colon; 9, the descending colon; 10, the sigmoid flexure; 11, the rectum.

22. *The walls of the stomach are composed of four coats:* the *serous* or external coat; the *muscular* coat, having its fibres arranged so as to enable it to contract in every direction; the *fibrous* coat, which gives it strength; and the *mucous* or lining membrane, which is soft and pulpy to the touch, and which exhibits a mammillated appearance, caused by its being everywhere minutely punctured by the orifices of the gastric glands. It is richly supplied with blood-vessels and lymphatics.

23. **The gastric glands** are tubular, and are very numerous in the mucous membrane. They are mostly simple, and many of them are lined with a columnar epithelium, similar to that of the lining membrane of the stomach. These glands secrete the *gastric juice.*

24. **The Small Intestine** is a cylindrical and much convoluted tube, extending from the stomach to the large intestine.

It is about one and a half inches in diameter, and twenty-five feet in length. It is divided into three portions: the *duode'num*, or widest portion, which is next to the stomach, and is "twelve fingers' breadth" in length; the *jeju'num*, which is the upper two-fifths, and the *il'eum*, which is the lower three-fifths of the remaining portion of the small intestine.

25. *The walls of the small intestine are composed of four coats, arranged like those of the stomach.* The mucous or lining membrane is thinner and redder than that of the stomach, and has a columnar epithelium. It forms folds or valves, called valvulæ conniventes, which are widest and most numerous in the upper part of the intestine. The mucous membrane contains numerous minute elevations, called **villi**, which are provided with a columnar epithelium, and which contain capillary blood-vessels and the commencement of those lymphatics, commonly called **lacteals.**

26. **The Large Intestine** is a cylindrical tube from two to two and a half inches in diameter, and about five feet in length. It is divided into four portions: the *cæcum*, next to the small intestine, and from two to three inches long; the *colon*, about four feet long, and named in different parts the ascending, the transverse, and the descending colon; the *sigmoid flexure;* and the *rectum*, or terminal portion, which is from six to nine inches in length. A worm-like tube, four or five inches long, and the size of a goose-quill, is attached to the end of the cæ'cum, and is called the appendix vermiformis. Its use is not known.

27. *The walls of the large intestine are composed of four coats*, arranged like those of the small intestine. The mucous or lining membrane is soft, smooth, and pale, and is provided with a columnar epithelium; but it is without the villi and the valves of the small intestine.

28. **The Pan'creas** is a flat, pinkish-white gland, situated behind the stomach. It is from six to eight inches long, and about one and a half inches broad; and it weighs from two to three ounces. It secretes the *pancreatic juice*, which passes

through the pancreatic duct into the duodenum, about four inches from the orifice of the stomach.

Fig. 27.

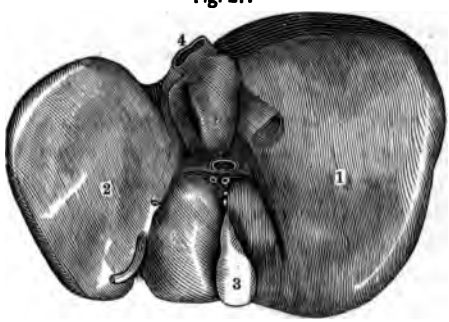


Fig. 27. A View of the Liver. — 1, The right lobe; 2, the left lobe; 3, the gall-bladder; 4, the inferior cava.

29. **The Liver** is the largest glandular organ in the body. It is situated in the right side of the abdomen, below and against the diaphragm, to which it is joined by ligaments. It has a firm texture, a smooth surface, and is of a reddish-brown color tinged with yellow. Its substance is divided into small lobes or lobules, which are held together by connective tissue. The liver is from nine to twelve inches long, from five to six inches broad, and weighs from three to four pounds. It is divided into two unequal parts, called the right and the left lobe; the right lobe being four or five times as large as the left one.

30. **The Gall-bladder** is situated on the under side of the right lobe of the liver. It contains the secretion of the liver, called *bile*, which passes through the hepatic duct into the duodenum, about four inches from the stomach. The hepatic duct is about three inches long, and of the diameter of a goose-quill.

31. **The Spleen** is situated in the left side of the abdomen, just below the diaphragm. It varies much in size; but is usually four or five inches long and three or four inches

broad, and weighs about six ounces. It has no duct, and its use in the system is not known.

QUESTIONS.

SECTION III.

1. What do the digestive organs include? Which of them form the alimentary canal?
2. Describe the mouth.
3. How is the palate divided? Describe each part. What is the uvula?
4. Describe the tonsils.
5. Describe the tongue.
6. Name the salivary glands. What do they secrete?
7. Describe the parotid gland.
8. Describe the submaxillary gland. The sublingual gland.
9. How are the teeth fixed in the jaws? What name is given to each part of the tooth?
10. Describe the pulp of the teeth. Describe the structure of the teeth.
11. How are these substances arranged in herbivorous animals? In carnivorous animals?
12. What is remarked of the two sets of teeth?
13. Describe the temporary teeth.
14. Describe the permanent teeth.
15. Describe the incisors. The canine teeth.
16. Describe the bicuspids. The molars.
17. How many roots have the different teeth?
18. Describe the pharynx. 19. The œsophagus. 20. The abdomen. The peritoneum. 21. The stomach. Its orifices. 22. Describe the coats of the stomach. 23. The gastric glands. 24. Describe the small intestine. 25. Describe its coats. What are the villi? 26. What is the large intestine? Describe its three portions. 27. Describe its coats. 28. Describe the pancreas. 29. The liver. 30. The gall-bladder. The hepatic duct. 31. The spleen.

SECTION IV.

PHYSIOLOGY OF THE DIGESTIVE SYSTEM.

1. **Digestion** is that process by which food in the alimentary canal is so changed that it may be absorbed by the lymphatics and the blood-vessels of the system. This process does not take place in vegetables; because they feed upon inorganic substances, which are in such a form as to be readily absorbed into their circulation. But man and other animals require organic substances, such as bread, meat, and vegetables, as a portion of their food; and these substances are more or less solid, and must undergo a change before they can be absorbed.

2. *The general characters of digestion are the same in all cases.* The food is taken into the mouth and passes through the alimentary canal, meeting in its passage certain digestive fluids, which prepare it for absorption. The food consists of a variety of substances, differing from each other; and the digestive fluids also differ in their composition, so that the action of each one of them is more or less confined to certain kinds of food. As the food becomes digested in its passage through the intestines, it is removed by absorption, leaving the indigestible parts to be discharged from the large intestine.

3. *The digestive organs vary in the different species of animals according to the nature of their food;* but they are always more complex in the herbivora than in the carnivora. Vegetable substances are usually more indigestible than animal substances; hence, the alimentary canal is longer and larger in herbivorous than in carnivorous animals. In man, the digestive organs are very similar to those of the carnivora, although his food is of a mixed character.

4. In the passage of the food through the alimentary canal, it meets with **five different digestive fluids**: the saliva, in the mouth; the gastric juice, in the stomach; and the bile,

the pancreatic juice, and the intestinal juice, in the small intestine.

5. In the mouth the food undergoes two operations; **mastication and insalivation.** The first consists in cutting and grinding the food into fine particles by the teeth, so that all parts of it may be acted upon more readily by the digestive fluids. The thorough mastication of the food is an important part in the process of digestion; for when food is hastily swallowed, in large masses, it remains a long time undigested in the stomach, and becomes a source of pain and irritation.

6. During the process of mastication the food is thoroughly mixed with the saliva from the salivary glands. **Saliva** is a colorless, slightly alkaline fluid, rendered more or less viscid by a substance named *ptyalin*, which is secreted from the submaxillary and sublingual glands. Only a little saliva is secreted while the jaws remain at rest, but during the movements of mastication, it flows in more abundance. Even the sight or odor of food, when we are hungry, will stimulate the flow of saliva, and, as is often expressed, "make the mouth water." The amount of saliva secreted in twenty-four hours, has been estimated by Dr. Dalton to be rather less than *three pounds.*

7. *The function of the saliva in digestion is only a physical one.* Its action is to moisten the food, thus facilitating its mastication, and lubricating it so that it passes more easily down the œsophagus to the stomach. Hard, dry food, such as crackers, requires much saliva to moisten it; soft and moist food requires less moistening; and liquids, such as soup or milk, do not require any moistening, but pass at once into the stomach. The food may be moistened by water instead of saliva, without interfering with the chemical changes in digestion.

8. *In the stomach the food meets with the gastric juice,* which is a clear, colorless fluid having an acid taste. It consists principally of water, holding in solution lactic acid, the chloride and phosphatic salts, and a peculiar principle,

called *pepsin*. The gastric juice may be kept a long time in a glass-stoppered bottle without putrefying. In this respect it differs from all other fluids of the body.

9. *The gastric juice is secreted in greatest abundance during digestion.* It begins to flow in a few minutes after the introduction of food, and continues from nine to twelve hours, depending upon the quantity of food eaten. The gastric juice acts as a **solvent on the albuminoid substances**, such as flesh, cheese, eggs, and the gluten of vegetables, changing them into a digested mass, called **albuminose**; but it does not in the slightest degree digest starchy or fatty substances. Fatty matters in the stomach are simply melted by the heat of the body; and starchy matters are gelatinized by the gastric juice, the same as they would be by water.

10. During digestion the fibres of the muscular coat undergo alternate contraction and relaxation, by which the food is carried back and forth through the stomach, and is thoroughly incorporated with the gastric juice. This is called the *peristaltic movement* of the stomach. The length of time required for digestion, according to Dr. Beaumont, is from one to five and a half hours, depending upon the kind of food eaten.

11. *The quantity of gastric juice secreted in twenty-four hours, has been estimated to be about fourteen pounds.* This is mixed with the food as rapidly as it is secreted, and when it has performed its office in the digestion, it is re-absorbed along with the food and again enters the circulation; therefore, during digestion, the digestive fluids are constantly flowing from the blood-vessels to the alimentary canal, and from the alimentary canal back again to the blood-vessels.

12. Although the gastric juice is such a powerful solvent, **it does not act upon living animal substances**; therefore, the stomach and intestines are not injured by it during life; but when death takes place, the coats of the stomach are attacked, and more or less digested by this fluid. No plausible reason for this protection of the stomach during life has been given.

13. The starchy and the fatty substances are not digested by the gastric juice; and, therefore, must pass unchanged into the small intestine, where they are subjected to the action of the intestinal juices, the pancreatic juice, and the bile.

14. **The Intestinal juice** is a clear, colorless, alkaline fluid, and has the property of rapidly converting *starch into sugar.* **The Pancreatic juice** is a clear, colorless, alkaline fluid, containing a peculiar principle, called *pancreatin.* It possesses the property of converting *starch into sugar*, and it is the active agent in the digestion of *fatty substances*, converting them into a milky fluid, called *chyle.* The amount of the pancreatic juice, secreted in twenty-four hours, has been estimated to be rather less than *two pounds.*

15. **The Bile** is a viscid, dark golden-brown fluid, having a very bitter taste, and is neither acid nor alkaline. It contains the peculiar principle, called *biliverdin*, which is its coloring matter. It is this that gives the yellow color to the body in the disease known as Jaundice. The bile, unlike the other fluids which assist in digestion, is a constant secretion, and continues even after an animal has been kept ten or twelve days without food. Its secretion, however, is increased during digestion, so that it amounts in the twenty-four hours to nearly *two and a half pounds.*

16. The particular use of the bile in the process of digestion, has not yet been determined; but experiments prove that this secretion must be discharged into the intestine, and be mixed with the food, or death will finally result. It is probable, however, that the bile undergoes some change in the small intestine, and is then absorbed along with the chyle into the circulation.

17. From the above we find the food is changed into three substances, during digestion. The gastric juice changes the albuminoid substances into **albuminose**; the pancreatic juice changes the fat into **chyle**; and the mixed intestinal juices change the starch into **sugar.** All these substances are mixed together in the small intestine, under the general name of chyle, whence they are taken into the circulation.

18. All food taken into the system belongs to one or more of the following classes, the fats, the starchy matter, or the albuminoid substances; and the process by which these are digested may be summed up as follows:

Fig. 28.

Fig. 28. A VIEW OF THE DIGESTIVE ORGANS OF THE COMMON FOWL.—1, The œsophagus; 2, the crop; 3, the secreting stomach; 4, the gizzard; 5, the intestine.

1st. **The food** is taken into the *mouth*, where it undergoes mastication and insalivation, and is thus prepared for deglutition.

2d. It passes from the mouth through the pharynx and the œsophagus into the *stomach*. Here it is subjected to the action of the gastric juice, which digests the albuminoid substances in it, and changes them into **albuminose.**

3d. As rapidly as the food is digested in the stomach, it passes into the *small intestine*, where it is subjected to the intestinal juice, the bile, and the pancreatic fluid, which digest the starch and fat, changing the starch into **sugar**, and the fat into **chyle.** The albuminose and the sugar are mixed with the chyle, which gives them a milky appearance, so that the whole digested mass in the small intestine is called chyle.

4th. *The chyle is absorbed from the small intestine* by the lacteals and the blood-vessels, and taken into the circulation, where it furnishes nourishment and support to the whole system.

5th. The innutritious and the undigested parts pass on into the large intestine, to be excreted from the body.

19. **In birds** that feed mostly upon grain and insects, as the common fowl, the food passes down the Œsophagus (1) into a pouch (2), called the Crop. After remaining here for a time, it passes into a second pouch (3), and afterwards into the Gizzard (4), which is provided with very thick walls. Here the food is subjected to a grinding action, which is facilitated by the grains of sand and gravel which the fowl swallows instinctively with its food. It then passes into the intestine (5), where the intestinal juices complete the digestion.

Fig. 29.

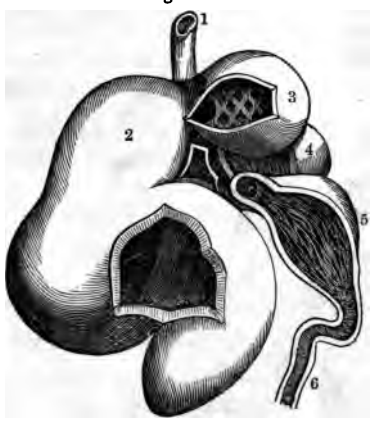


Fig. 29. A View of some of the Digestive Organs of an Ox.—1, The œsophagus; 2, the rumen or paunch; 3, the reticulum; 4, the omasus; 5, the abomasus or rennet; 6, the intestine.

20. **The ox, the deer, the sheep,** and all other ruminating animals, have four stomachs. Their food is of a vegetable nature, and passes from the mouth down the Œsophagus (1) into the Rumen or Paunch (2). Here it remains until the animal is done feeding, and the process of ruminating, or chewing the cud, commences. The food is then regurgitated into the mouth, and slowly masticated, after which it is again swallowed, but this time it is turned by means of a valve into the Reticulum (3). It next passes into the Omasus (4),

thence into the Abomasus, or Rennet (5), which is the true digestive stomach, and then into the small intestine. It is acted upon by the fluids in each stomach, but is not fully digested until it has passed through them all.

QUESTIONS.

SECTION IV.

1. What is digestion? What kind of food is needed by vegetables? By animals?
2. State the general characters of digestion.
3. What is remarked of the digestive organs in different species of animals?
4. Mention the digestive fluids in the alimentary canal.
5. What operations does the food undergo while in the mouth? What is said of mastication?
6. When is the food insalivated? Describe the saliva, and when secreted.
7. What is said of the function of the saliva?
8. Describe the gastric juice.
9. When is the gastric juice secreted? How does it act upon the food?
10. Describe the peristaltic movement of the stomach. What length of time is required for digestion?
11. What quantity of gastric juice is secreted? What becomes of it?
12. What is said of the action of the gastric juice on the coats of the stomach?
13. What kinds of substances are not digested by the gastric juice?
14. Describe the intestinal juice. The pancreatic juice.
15. Describe the bile.
16. Of what use is the bile in digestion?
17. Into what is the food changed during digestion?
18. Of what is all food taken into the system composed? 1st. What takes place while the food is in the mouth? 2d. While in the stomach? 3d. While in the small intestine? 4th. What becomes of the chyle? 5th. What becomes of the undigested portions?
19. Describe digestion in birds.
20. Describe digestion in the ruminating animals, as the ox, deer, and sheep.

SECTION V.

ANATOMY OF THE CIRCULATORY SYSTEM.

1. **The Organs of Circulation** comprise the heart, the arteries, the capillaries, and the veins.

2. **The Heart** is the chief agent in the circulation. It is a hollow muscular organ, situated between the lungs in the thorax, but more to the left than to the right side. It is conical in shape, and is everywhere free, except at its base, where it is attached to the front of the spinal column by means of the large blood-vessels. The base is directed upward, backward, and to the right, and extends from the fourth to the eighth dorsal vertebra; and the apex is directed downward, forward, and to the left, and is opposite to the cartilage of the sixth rib. The length of the heart is about five inches, and the breadth about three and a half inches, and its average *weight is ten ounces.*

Fig. 30.

Fig. 30. THE HEART AND LARGE BLOOD-VESSELS. — 1, Right ventricle; 2, left ventricle; 3, right auricle; 4, left auricle; 5, aorta; 6, pulmonary artery; 7, right subclavian artery; 8, right common carotid; 9, left subclavian; 10, left common carotid; 11, superior cava; 12, pulmonary vein.

3. *The interior of the heart* is separated by a muscular partition into two parts, called the right and the left side; and each side is again separated into an **auricle**, next to the base of the heart, and a **ventricle**, next to its apex. The ventricles are larger and stronger than the auricles; and the left side of the heart is larger and stronger than the

Fig. 30.

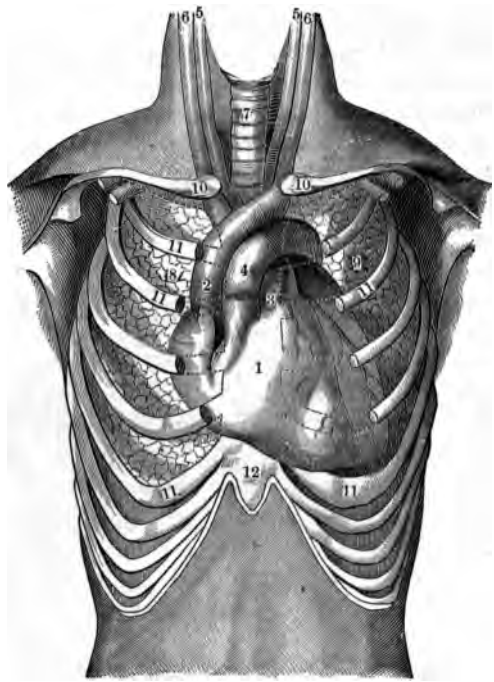


Fig. 30. A VIEW OF THE CHEST, SHOWING THE POSITION OF THE HEART, THE LUNGS, AND THE LARGE BLOOD-VESSELS.—1, The heart; 2, the superior cava; 3, the pulmonary artery; 4, the aorta; 5, the carotid arteries; 6, the jugular veins; 7, the trachea; 8, the right lung; 9, the left lung; 10, the clavicle; 11, the ribs; 12, the lower part of the sternum.

right side. Each ventricle will hold from four to six cubic inches of blood, equal in amount to two or three ounces. The capacity of the auricles is rather less than that of the ventricles.

4. **The right auricle** has thin, translucent walls, and has the superior and the inferior cava opening into its cavity. **The left auricle** has thicker and less translucent walls, and has the four pulmonary veins opening into its cavity. **The right ventricle** has walls about the fourth of an inch thick; and it gives off the pulmonary artery to the lungs. **The left ventricle** has walls nearly an inch thick; and it gives off the large artery, called the Aorta. The thickness of the walls is in proportion to the force which they exert.

5. *The valves of the heart* are the tricuspid valve, the semilunar valves, and the mitral valve. **The Tricus'pid valve** separates the right auricle from the right ventricle. It consists of three membranous folds, which are pressed against the sides of the ventricle, when the valve is open, but which close the orifice between the auricle and the ventricle, when the valve is shut. **The Semilu'nar valves** are in the pulmonary artery, where it springs from the right ventricle, and in the aorta, where it springs from the left ventricle. They are composed of three membranous folds, arranged in a circle, so as to close the orifice when they are shut. **The Mi'tral valve** separates the left auricle from the left ventricle. It consists of two folds, which act like the tricuspid valve to close the orifice between the auricle and the ventricle, when the valve is shut.

6. *The muscular fibres composing the walls of the heart* are exceedingly complex in their arrangement, crossing each other in various ways, so as to produce the peculiar movements of that organ. The heart is inclosed in a fibro-serous sac, which consists of two layers, and is called the **Pericar'dium.** The external layer is a strong membrane of fibrous tissue; but the internal layer is a serous membrane, one portion of which closely invests the heart, and the other

lines the inner surface of the external layer, so that the two surfaces thus rubbing together at each pulsation of the heart are very smooth, and are bathed with an oily fluid, which tends to lessen the friction between them.

7. The interior of the heart is lined with a very smooth serous membrane, called the **Endocar'dium**, which is similar to that lining the blood-vessels. The endocardium consists of an epithelium of pavement-like cells, and a fibro-elastic layer, which is closely united to the muscular structure of the heart.

8. A good idea of the structure and the appearance of the human heart and its valves, may be obtained by examining the heart of an ox, which is very similar to that of the human being.

9. **The Arteries** are cylindrical tubes, which spring from the ventricles of the heart in two great trunks; the Pul'monary artery from the right ventricle, and the Aor'ta from the left ventricle. They give off branches, and thus distribute the blood to all parts of the body. The course of the larger arteries is mostly along the bones, where they are better protected by the muscles and other soft parts. The arteries frequently communicate with each other by *anastomoses*, or connecting branches, thus affording several channels for the passage of the blood to every part of the system.

10. *The walls of the arteries are composed of three coats:* the external coat, which is mainly of fibrous tissue, giving firmness and strength; the middle, or thickest coat, which is composed of elastic and muscular tissue, giving elasticity, contractility, and strength; and the internal coat, which is thinnest and most elastic, and is similar to the lining membrane of the interior of the heart.

11. As the arteries pass from the heart, they give off branches similar to the branching of a tree, and thus become smaller and smaller until they are called capillaries. **The Cap'illaries** are minute blood-vessels, ranging in size from the $\frac{1}{8000}$ to the $\frac{1}{12000}$ of an inch in diameter, and connecting

the termination of the arteries with the commencement of the veins. In structure, they have only a single layer of transparent, elastic, structureless membrane. They form a *network* in all parts of the body; but are most numerous in the lungs, the liver, the kidneys, the skin, the mucous membrane, and the muscles, where they are so close together that the finest puncture cannot be made anywhere without wounding some of them.

12. **The Veins** are cylindrical tubes, like the arteries, but are larger and more numerous. They commence at the capillaries, and gradually converge, or run together, as they approach the auricles of the heart, until those from the body finally terminate in two large venous trunks, called the superior cava and inferior cava, which empty into the right auricle; and those from the lungs terminate in the four pulmonary veins, which empty into the left auricle.

13. The larger veins consist of a *superficial set*, which run immediately beneath the skin; and a *deep set*, which usually accompany the arteries, and are called companion veins. Anastomosis between veins is more common than between arteries. Many of the larger veins, particularly in the upper and the lower extremities, are provided with valves, arranged in pairs opposite to each other, so as to prevent the reflux of the blood. *The walls of the veins are composed of three coats*, very similar to those of the arteries.

Fig. 32.

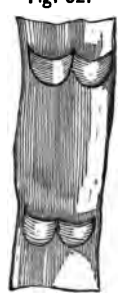


Fig. 32. A Vein Opened so as to show the Valves in Pairs.

14. **The Aor'ta** is the large artery springing from the *left ventricle* of the heart. It ascends from the heart, and arches from the right to the left of the spinal column; then it descends through the body, receiving the names of thoracic aorta and abdominal aorta, and finally divides opposite the fourth lumbar vertebra into the iliac arteries. The arteries given off from the arch of the aorta, are the right coronary, the left coronary, the innominate, the left common carotid, and the left subclavian artery.

15. **The right cor'onary artery** goes to the right side, and the **left cor'onary artery** to the left side of the heart. **The innom'inate artery** ascends about one and a half inches, then

Fig. 33.

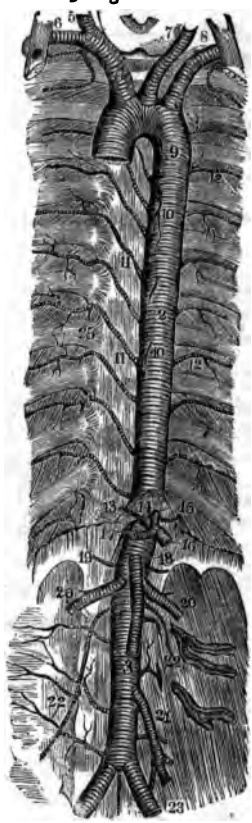


Fig. 33. THE AORTA AND ITS BRANCHES.—1, The arch of the aorta; 2, thoracic aorta; 3, abdominal aorta; 4, innominate artery; 5, right common carotid; 6, right subclavian; 7, left common carotid; 8, left subclavian; 9, bronchial artery; 10, œsophageal arteries; 11, intercostal arteries of the right side; 12, intercostal arteries of the left side; 13, phrenic arteries; 14, cœliac axis; 15, coronary artery; 16, splenic artery; 17, hepatic artery; 18, superior mesenteric artery; 19, supra-renal arteries; 20, renal arteries; 21, inferior mesenteric artery; 22, lumbar arteries; 23, common iliac arteries.

divides into the right common carotid, and the right subclavian artery, which are similar to those of the left side.

16. **The common carot'id arteries** ascend the neck, one on each side, to the upper border of the larynx, where each one divides into the external carotid, and the internal carotid artery.

Fig. 34.

Fig. 34. The Carotid Arteries.—1, Right common carotid; 2, internal carotid; 3, external carotid; 4, superior thyroid; 5, lingual; 6, facial; 7, submental; 8, inferior coronary; 9, superior coronary; 10, muscular branches; 11, lateral nasal artery; 12, angular artery; 13, occipital artery; 14, descending cervical; 15, muscular branch; 16, posterior auricular artery; 17, parotid branches; 18, internal maxillary; 19, temporal; 20, transverse facial; 21, anterior auricular; 22, supra-orbital; 23, middle temporal; 24, anterior temporal; 25, posterior temporal artery.

17. **The external carot'id artery** supplies all parts of the head, except the brain and the orbits. It gives off the superior thyroid artery to the thyroid gland, the lingual artery to the tongue, the pharyngeal artery to the pharynx,

the facial artery to the face, the occipital artery to the back part of the head, the parotid arteries to the parotid gland, the temporal artery to the temporal region of the head, and the internal maxillary artery to the teeth, the gums, the lower eyelid, the upper lip, the palate, and the nose.

Fig. 35.

Fig. 35. ARTERIES OF THE FOREARM. — 2, The brachial artery; 4, radial artery; 5, ulnar artery; 6, recurrent artery; 7, interosseous artery; 11, superficial palmar arch; 12, artery to the thumb; 13 and 14, arteries to the fingers.

18. **The internal carot'id artery** supplies the brain and the orbits. It gives off the cerebral artery to the brain, and the ophthalmic artery to the orbit and its contents.

19. **The subcla'vian arteries,** one on each side, curve outwardly, and pass over the first rib, when each assumes the name of axillary artery. The subclavian artery gives branches to the brain, the spinal column, the ears, the pleura, and to the muscles of the neck, the chest, and the abdomen.

20. **The ax'illary artery** gives branches to the chest and the shoulder, and passes along the inner side of the arm where it receives the name of **brachial artery.** At the elbow, the brachial artery divides into the **radial artery** and the **ulnar artery,** which supply the forearm and the hand. The radial artery passes along the outer side, and the ulnar artery along the inner side of the forearm, until they reach the palm of the hand. Here they are united by two communicating arteries, forming the deep palmar arch, and the superficial palmar arch, which give branches

to the palm of the hand, the thumb, and the fingers. The **pulse** may be easily counted in the radial artery at the wrist.

21. **The thorac'ic aorta** commences at the arch of the aorta and descends along the left side of the spinal column to the last dorsal vertebra, where it passes through the diaphragm, and is then called the abdominal aorta. It gives small branches to the pericardium, the bronchi, the œsophagus, the pleura, and to the intercostal muscles.

22. **The abdom'inal aorta** inclines a little to the right, and then descends in front of the spinal column to the fourth lumbar vertebra, where it divides into the two iliac arteries. Its branches are the **cœliac axis**, which gives the *coronary artery* to the stomach, the *hepatic artery* to the liver, and the *splenic artery* to the spleen and pancreas; two **mesenteric arteries**, which supply the small and the large intestine; the two **phrenic arteries**, which supply the diaphragm; the two **renal arteries**, which supply the kidneys; and the **lumbar arteries**, which supply the muscles of the back and of the abdomen.

23. **Each il'iac artery** is divided into the internal iliac and the external iliac artery. **The internal iliac** supplies the contents of the pelvis; and **the external iliac** passes to the inner side of the thigh, where its upper part is called the femoral, and its lower part, towards the knee, is called the popliteal artery.

24. **The poplit'eal artery** passes behind the middle of the knee-joint; and then divides into the anterior tibial and the posterior tibial artery. **The anterior tibial artery** descends in front of the tibia and over the instep, supplying the upper parts of the foot. **The posterior tibial artery** descends along the back of the leg to the heel, and curves under the inner ankle to the hollow of the foot, where it joins with the anterior tibial artery, and forms the plantar arch which gives branches to the toes and the bottom of the foot.

25. **The cor'onary vein** and its branches convey the blood from the walls of the heart to the right auricle.

26. *The veins of the upper limbs* converge, or

together, and thus grow larger as they approach the shoulder. Each artery of the arm has two companion veins, but these unite into one vein at the axilla. Besides these deep veins, there is a superficial set; the radial, the median, and the ulnar vein, below the elbow, and the cephal'ic and basil'ic vein above that joint.

27. All the veins of the arm unite at the axilla, and thus form the **subcla'vian vein,** which receives the **external ju'gular vein** with its blood from the exterior of the head, and from a portion of the face and the neck. It then unites with the **internal ju'gular vein,** which returns the blood from the interior of the skull and the orbits, and from the remaining portion of the face and the neck.

28. After the subclavian vein unites with the internal jugular vein, it is called the innominate vein; and the **innom'inate veins,** one on each side, unite to form the **Superior Ca'va,** which descends on the right of the aortic arch, and terminates in the right auricle of the heart.

29. *The deep veins of the lower limbs* accompany the arteries, and are finally united into the femoral vein, on the inner side of the thigh. The superficial veins also unite as they pass towards the body and empty into the femoral vein, which then ascends into the pelvis, where it is called the iliac vein.

30. **The il'iac veins,** one from each limb, finally unite and form the **Inferior Ca'va** which ascends in front of the spinal column to the right of the aorta, and terminates in the right auricle of the heart. It is larger in diameter than the aorta; and it receives the veins from the abdominal viscera and the muscles of the back.

31. **The Pul'monary artery** ascends about two inches from the right ventricle, and then divides into the right pulmonary artery which goes to the right lung, and the left pulmonary artery which goes to the left lung.

32. **The Pul'monary veins** are the two right pulmonary veins from the right lung, and the two left pulmonary veins from the left lung. They all terminate in the left auricle.

QUESTIONS.

SECTION V.

1. What do the organs of circulation comprise?
2. Describe the heart. Its size and weight.
3. How is the interior of the heart divided? What is the capacity of each cavity?
4. Describe the right auricle. The left auricle. The right ventricle. The left ventricle.
5. Name the valves of the heart. Describe the tricuspid valve. The semilunar valves. The mitral valve.
6. What is said of the muscular walls of the heart? Describe the pericardium.
7. Describe the endocardium.
8. How may a good idea of the valves of the heart be obtained?
9. What are the arteries? What is said of the course of the larger arteries? What of their connecting branches?
10. Describe the walls of the arteries.
11. How do the arteries branch? Describe the capillaries.
12. What are the veins? What is said of their course?
13. What is remarked of the two sets of veins? What of the valves in the veins? Of what are their walls composed?
14. Describe the course of the aorta.
15. What is said of the coronary arteries? The innominate artery?
16. The common carotid arteries?
17. The external carotid and its branches?
18. The internal carotid and its branches?
19. The subclavian arteries?
20. The axillary artery? The brachial artery and its branches to the arm and hand?
21. The thoracic aorta and its branches?
22. The abdominal aorta and its branches?
23. The iliac arteries and their branches?
24. The popliteal artery and its branches to the leg and foot?
25. What is said of the coronary vein?
26. What is said of the veins of the upper limbs?
27. What of the subclavian and the jugular veins?
28. What of the innominate veins and the superior cava?
29. What of the veins of the lower limbs?
30. What of the iliac veins and the inferior cava?
31. Describe the pulmonary artery.
32. Describe the pulmonary veins.

SECTION VI.

PHYSIOLOGY OF THE CIRCULATORY SYSTEM.

1. **The fluid** which circulates in the heart and blood-vessels of the body, is called **blood.** It is a thick, opaque liquid, of a bright red color in the arteries, and of a dark purple, or nearly black color in the veins. It is heavier than water, its specific gravity being 1055. The blood is divided into two parts; a multitude of minute cells, called *blood-globules*, and a colorless liquid, called the *plasma*.

2. *The blood-globules are of two kinds, the red and the white.* **The red globules** are very small, having an average diameter of $\frac{1}{3500}$ of an inch, and in shape resemble the common water-cracker of the stores. The size and structure of the red globules vary in different animals. In most mammals they are circular; but they are generally smaller than in man. **The white globules** are rather larger but much less numerous than the red, being in the proportion of one white globule to three or four hundred red globules. **The plasma** is the liquid in which the blood-globules float; and it is the nutritive part of the blood, which is absorbed from the capillaries by the organs and tissues of the body.

3. In every 1000 parts of the blood, 513 parts are globules and 487 parts are plasma, having the following composition:

1. 513 parts of globules, containing	Water,	350
	Globulin,	151
	Hematin,	8
	Salts,	4
2. 487 parts of plasma, containing	Water,	440
	Fibrin,	3
	Albumen,	40
	Salts,	4
		1000

4. *When the blood is removed from the body, it undergoes coagulation, or clotting,* which process is completed in about twenty minutes. This process depends entirely upon the

fibrin in the blood. After the clot is fairly formed, it begins to contract and continues for ten or twelve hours, during which time the whole of the blood is separated into two parts; called the *clot* and the *serum*. In this change, the fibrin leaves the plasma and unites with the globules, forming the clot; hence, the blood after coagulation is separated into

1. Clot, containing..... { Globules. Fibrin.
2. Serum, containing ..... { Water. Albumen. Salts.

5. *Whenever the circulation of the blood is retarded in the blood-vessels, a clot is formed.* This is one of the means by which nature checks hemorrhage from the smaller vessels, and it may be facilitated in various ways; such as by elevating the limb when it is wounded, and by making pressure upon the wound by bandages. After death, the blood coagulates in the heart and large blood-vessels. In man, this coagulation requires from twelve to twenty-four hours; but in the lower animals, from four to ten hours only are needed.

6. *The quantity of blood* in a healthy person is estimated to be about the one-eighth part of the entire weight of the body; hence, a man weighing one hundred and sixty pounds would have about *twenty pounds* of blood, equal to nearly *sixteen and a half pints.*

7. The blood holds in solution all the materials necessary for the formation of the tissues and organs of the body. These materials are obtained from the chyle in the small intestine, and are conveyed, by the blood, in its circulation through the vessels, to all parts of the system.

8. *The heart, by its alternate contraction and dilatation, forces the blood to circulate* through the blood-vessels. The contraction of the heart begins in the two auricles at the same moment and immediately extends to the ventricles, so that the contraction of the auricles and ventricles may be considered as one movement. The contraction of each cavity is imme-

diately followed by its dilatation. Then cómes a period of repose, during which the blood flows in a steady stream into the auricles and through the valves into the ventricles, until they are about two-thirds full. Then the contraction of the auricles begins again, and thus the alternate movements of contraction and dilatation are continued.

9. *The alternate contraction and dilatation of the heart produce its beating, or pulsation.* They also force the blood to pass in successive jets or waves through the arteries, thus constituting the *pulse.* There is no pulse however in the capillaries or the veins, and the blood in them moves in a steady stream; hence, when a vein is wounded, the blood flows steadily from it; but when an artery is wounded, the blood flows from it in successive jets. In the healthy adult the pulse beats from sixty to eighty times in a minute; but it is more frequent than this in children, and rather less frequent in old persons.

10. *The course of the circulation* is as follows: — The right auricle of the heart receives the blood of the body from the two large veins. By contracting it sends this blood into the right ventricle, which, in turn, contracts and sends it through the pulmonary artery to the lungs. It is then conveyed through the pulmonary veins to the left auricle of the heart. This is called the **Pul'monary circulation.**

11. The left auricle contracts and transmits the blood to the left ventricle, which, in turn, contracts and sends it through the aorta to all parts of the system, from which it returns through the capillaries and the veins to the right auricle. This is called the **System'ic circulation.**

12. In the capillary vessels, between the pulmonary artery and the pulmonary veins, *the venous blood is changed into arterial blood,* by absorbing oxygen from the air and giving off carbonic acid to it. In the capillary vessels, between the arteries and the veins, in the systemic circulation, *the arterial blood is changed into venous blood,* by absorbing carbonic acid from the tissues and organs of the body and giving off oxygen to them.

13. The pulmonary veins, the left auricle, the left ventricle, the aorta and other arteries, all contain *bright red, or arterial blood.* The veins, the right auricle, the right ventricle, and the pulmonary artery, all contain *dark purple, or venous blood.*

14. *The capacity of the venous system is about twice that of the arterial system.* During life, however, the veins are never full of blood, but the arteries are always full; hence, it has been estimated that there is one and a half times as much blood in the veins as in the arteries.

15. *The velocity of the blood in the arteries* varies from six to twenty inches in a second; the average velocity, however, is about *twelve inches in a second.* It is slower near the capillaries and more rapid near the heart. *The velocity in the capillaries* varies in different organs; but the average is about the *one-thirtieth of an inch in a second. The velocity in the veins* is more irregular than in the arteries; but the average is about *eight inches in a second.* It is slower near the capillaries and more rapid near the heart. The capacity of the aorta is not so great as the combined capacity of the small arteries; and the capacity of the two large veins is not so great as the combined capacity of the small veins, near the capillaries; hence, the blood must move most rapidly near the heart where the channel is smallest.

16. *The time required for the entire blood to pass the round of the whole system, cannot be absolutely fixed;* because its circulation is complicated in many ways. It has been estimated, however, to make the round to the lower limbs in about *thirty seconds.* Less time than this is required for it to pass through the head and upper limbs; but a longer time is needed to pass through the digestive organs.

17. *The circulation of the blood through the arteries is caused* by the contraction of the heart, which forces the blood into the arteries, and by the elasticity of the walls of the arteries, which contract upon the blood in them pressing it on into the capillaries. This pressure is probably sufficient to

cause the blood to flow through the capillaries in a continuous stream, and to pass into the veins, on its return to the heart. The circulation in the veins is caused by the movements of the chest in respiration, which gently draw the blood towards the heart; by the contraction of the voluntary muscles, which presses it onward through the veins, while the valves in them prevent its return; and by the force with which it enters the veins from the capillaries.

QUESTIONS.

SECTION VI.

1. What is said of the blood? How is the blood divided?
2. Describe the blood-globules. The plasma.
3. State the proportion of the globules and the plasma. Give the composition of the globules. Of the plasma.
4. What is remarked of the coagulation of the blood? What takes place in the blood during coagulation?
5. When does the blood coagulate? Of what use is this? What is said of coagulation after death?
6. What of the quantity of blood in the body?
7. What of the materials for nourishing the body?
8. Explain the alternate contraction and dilatation of the heart.
9. What is remarked of the pulse? How often does the pulse beat?
10. Describe the pulmonary circulation.
11. Describe the systemic circulation.
12. What change occurs in the blood while in the capillaries of the lungs? In the capillaries of the system?
13. Which of the circulatory organs contain arterial blood? Which contain venous blood?
14. What of the quantity of blood in the veins and in the arteries?
15. What of the velocity of the blood in the arteries? In the capillaries? In the veins? What of the relative capacity of the large and the small blood-vessels?
16. What of the time required to make the round of the circulation?
17. What causes the circulation through the arteries? Through the veins?

SECTION VII.

THE LYMPHATIC SYSTEM.

1. **The Lymphat'ic system** consists of lymphatic vessels and lymphatic glands, both of which are called lymphatics. **The lymphatic vessels** are found in most of the tissues and organs of the body that receive blood, except that none have been detected in the substance of the brain, the spinal cord, or the eyeball. They consist of a deep and a superficial set. The deep lymphatics follow the course of the arteries, while the superficial lymphatics are mostly found near the skin.

2. *The finer lymphatic vessels are long, thread-like, transparent tubes,* and are more numerous than either the arteries or the veins. Many of them are so small that they can scarcely be detected, unless some colored liquid is first injected into them. They gradually unite with each other, and thus become larger and larger as they approach the two great lymphatic trunks; called the thoracic duct, and the right lymphatic duct.

3. **The thorac'ic duct** commences just below the diaphragm, and ascends in front of the spinal column to the apex of the chest, where it curves and empties into the left subclavian vein. It is about the diameter of a goose-quill, and its walls are composed of three coats, similar to those of the veins. **The right lymphat'ic duct** is about half an inch in length, and empties into the right subclavian vein. The lymphatics from the right side of the head and the neck, and from the right arm, empty into the right lymphatic duct; but the lymphatics from all other parts of the body, empty into the thoracic duct.

4. *Nearly all the smaller lymphatic vessels pass through lymphatic glands* in their course to the great trunks. These glands are moderately hard bodies, of a pink color, and vary in size from that of a hemp-seed to an almond. They are

Fig. 36.

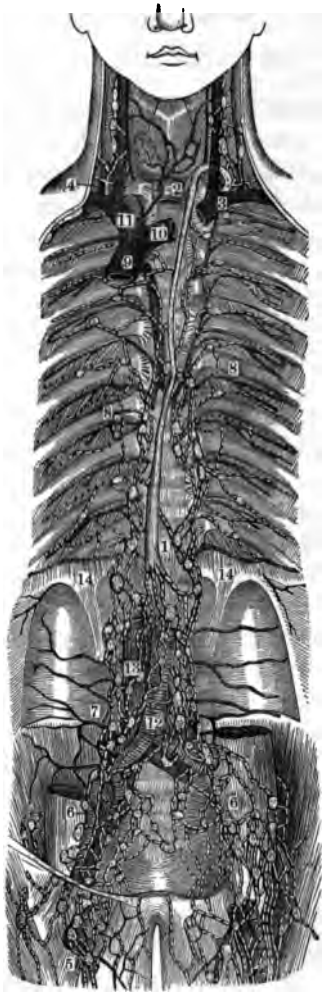


Fig. 36. THE LYMPHATIC TRUNKS.—1, 2, Thoracic duct; 3, its termination in the left subclavian vein; 4, the right lymphatic duct; 5, lymphatics of the thigh; 6, lymphatics of the pelvis; 7, of the back; 8, of the chest; 9, superior cava; 10, left innominate vein; 11, right innominate vein; 12, aorta; 13, inferior cava; 14, origin of the diaphragm.

most numerous along the course of the larger blood-vessels, and in the axilla, the groins, the sides of the neck, the bronchi, and the abdomen. These glands swell when they are inflamed, and are then called "kernels."

5. *The lymphatic vessels contain lymph*, which is a colorless, transparent fluid, consisting of water, saline matters, fibrin, and albumen. The lymph is obtained from the disintegration of the tissues which are changed to a fluid form, and are then absorbed into the circulation, so as to be eliminated from the system by the secretory organs.

6. **The lymph**, when obtained pure from the thoracic duct, is remarkably similar to the composition of the blood **plasma**. When taken from the body, it coagulates, and separates into the clot and the serum, the same as the blood. During the digestion of the food, and its absorption by the lacteals, the lymph has the addition of the milky chyle, giving it a white appearance; but during the intervals of digestion, it is a clear and colorless liquid. In a man weighing one hundred and forty pounds, the total amount of lymph and chyle passing through the lymphatics, in twenty-four hours, is about *six and a half pounds*, nearly four pounds of which are pure lymph.

7. **The villi**, which are very numerous throughout the length of the small intestine, contain capillary blood-vessels and the lymphatics, called *lacteals*. During the passage of the digested food, or chyle, through the intestine, it is gradually absorbed by both the blood-vessels and the lacteals, so that, at the termination of the small intestine, the refuse and the indigestible part of the food only remain to pass into the large intestine.

8. *The chyle absorbed by the blood-vessels* is carried through the capillary circulation of the liver, by which all parts of it, except the fat, are changed into substances similar to those previously existing in the blood. It then passes to the right side of the heart, and through the capillaries of the lungs, where the fat disappears; but what becomes of it is not definitely known.

9. *The chyle absorbed by the lacteals* is carried by the thoracic duct into the left subclavian vein, whence it goes to the right side of the heart, and through the capillaries of the lungs where the fat disappears. When the digestion is active, the chyle is absorbed more rapidly than it can be changed in the lungs, and a portion of it is then found unchanged in the general circulation; but when digestion is completed, it is soon assimilated to the other ingredients of the blood, and all traces of it disappear.

10. When the blood containing this nourishment reaches the capillaries, the nutrient parts of it are absorbed by the various organs and tissues of the body. Thus the bones, the muscles, the tendons, the nerves, the lungs, the heart, the liver, the brain, the eye, and other organs, each absorbs from the blood the particular materials needed for its own growth and development.

11. When more of these materials are absorbed than are needed to supply the waste of the system, they are deposited in different parts of the body *in the form of fat;* but when they are insufficient to supply the system, which is the case in sickness, and when food cannot be obtained, this fat is re-absorbed by the lymphatics, and is conveyed again into the blood so as to nourish the body. This explains why the fat is removed from the orbits, the cheeks, and other parts of the body, during any protracted illness.

12. *The lymphatic vessels all pass from without inward,* and none pass from within outward; hence, the peculiarity of the lymphatic system is that the lymph and chyle always flow in one direction, which is towards the thoracic duct, or the right lymphatic duct. The lymph, therefore, does not circulate like the blood.

13. *The lymphatic vessels are provided with valves,* arranged like those of the veins, which allow the lymph and chyle to pass readily towards the two great ducts, but which prevent its flow in an opposite direction. The passage of the lymph through these vessels is caused by the movements of the chest

in respiration, the contraction of the voluntary muscles, and the force with which it is absorbed by the small lymphatics. These forces are the same as those which cause the blood to pass through the veins.

QUESTIONS.

SECTION VII.

1. Of what does the lymphatic system consist? Where are lymphatics found?
2. What is said of the finer lymphatics?
3. Describe the thoracic duct. The right lymphatic duct. What vessels empty into each duct?
4. What is said of the lymphatic glands?
5. What of the lymph in the lymphatics?
6. What resemblance is there between the lymph and the blood plasma? How is the lymph changed during digestion? What is said of the quantity of lymph in the body?
7. What do the intestinal villi contain? Of what use are these vessels?
8. What is done with the chyle absorbed by the blood-vessels?
9. What with the chyle absorbed by the lacteals?
10. What is done with this nourishment in the blood?
11. What is remarked of the deposits of fat?
12. What is peculiar in the flow of lymph and chyle?
13. What causes the lymph to flow through the lymphatics?

SECTION VIII.

ABSORPTION, SECRETION, AND EXCRETION.

1. **Absorption** takes place through the different membranes of the body, both by the *lymphatic and the capillary vessels.* The food is absorbed through the mucous membrane of the alimentary canal, and gases through that of the lungs. In this way, contagious and miasmatic matters and other impu-

rities in the air, are introduced into the system. Even solid particles when fine, such as arsenic from artificial flowers and from green wall-paper, have been absorbed through the mucous membrane of the lungs so as to produce poisoning.

2. *Absorption also takes place through the skin*, so that thirst may be partially relieved by immersing the body in water; and even life may sometimes be prolonged by immersing the patient in milk. When the cuticle is removed, various substances, if finely powdered, may be absorbed into the system; hence, care should be taken, when handling poisons, that the skin is unbroken.

3. The liquid poured out by the serous membranes when inflamed, as in the joints, the pleural cavities, the pericardium, and the peritoneum, giving rise to local dropsy, is often removed by absorption; and even the muscles and the bones have been disintegrated and absorbed.

4. The principal *secretions and excretions* of the human body are:

1. Mucus.
2. Sebaceous matter.
3. Perspiration.
4. The tears.
5. The serous fluid.
6. Saliva.
7. Gastric juice.
8. Pancreatic juice.
9. Intestinal juice.
10. Bile.

5. Several of these fluids are discharged into the alimentary canal, and are re-absorbed into the blood along with the chyle from the small intestine. It is estimated, in a person weighing one hundred and forty pounds, that over *twenty-five pounds* of mucus, saliva, gastric juice, bile, pancreatic juice, and intestinal juice, are secreted from the blood and re-absorbed into it again in twenty-four hours. This exhibits the great activity of the secretion and the absorption, which are always going on in the living body.

6. These fluids are formed from the blood by the different organs, and are then conveyed into the alimentary canal, where they assist in the physical and chemical changes

necessary to prepare the food ready for absorption into the system; and, having performed this office, they are re-absorbed, along with the food, and carried back into the blood. They seem thus to be sent out by the blood to bring in provisions, and when they return they are laden with nourishment for every tissue and organ of the body. Thus new material is constantly furnished by the blood for making new growth.

7. While all parts of the body are constantly receiving this new material, they are constantly losing their old and worn-out matter. The substances thus formed in the tissues, by the waste and decomposition going on in them, are taken up by the lymphatics and the capillaries, and are conveyed to certain organs, such as the skin, the lungs, and the kidneys, by which they are finally expelled from the system. If these substances be not removed, they accumulate in the blood and the tissues, and soon clog up the wheels of life; thus preventing the changes which are constantly required to preserve a state of health. They act soonest on the nervous centres, producing irritability, delirium, and finally death; and a fatal result is sure to follow, sooner or later, when any one of the excretions is checked so as to accumulate in the body.

8. In a healthy person, weighing one hundred and forty pounds, about *seven pounds* of material are absorbed into the body from without, and seven pounds are discharged or excreted from the body in twenty-four hours; thus showing that a quantity of matter equal to the entire weight of the body, passes through it in twenty days.

9. *The component parts of every living body are necessarily in a state of change*, for it is an essential condition of their existence that there should be an incessant renewal of their structure. There is a continual absorption of materials from without to supply this incessant growth, which is going on in all the tissues, and the secretory and excretory organs, like faithful scavengers, are continually at work to carry away the products of their decomposition.

10. *The life of the body is but a round of unceasing change.* The food is taken into the system, where it is assimilated to the different organs and tissues of the whole body, and like them, becomes endowed with life. Here it remains performing its office for an allotted time, then it loses its vitality and must be removed from among the living, where its presence can no longer be of use. Thus life and death are ever busy in all parts of the living frame. In youth, the powers of life are stronger than those of death, and the body grows faster than it decays; hence, it increases in size and strength until it becomes a full-grown man or woman; in middle age, these forces are more evenly balanced, and neither one can claim much advantage; but as old age comes on, life is on the wane, the growth becomes more and more feeble, while waste and decay still go on, until death finally steps in and ends the scene! It has been truly said, "in the midst of life we are in death;" and when we come to understand these changes of life and death, constantly occurring in our own bodies, how clearly shall we behold in them the conceptions of the Infinite One, and be made to feel that we are indeed both "fearfully and wonderfully made"! May these truths teach us the reverence due to Him who is over and above all!

QUESTIONS.

SECTION VIII.

1. By what vessels does absorption take place? What is said of absorption through mucous membranes?
2. What of absorption through the skin?
3. What of absorption of the serous fluid and of bone?
4. Name the secretions and excretions.
5. What is said of the secretions that are re-absorbed?
6. Whence do these fluids come, and what is their function?
7. What change is constantly taking place in the body? If the excretions be not removed what must result?
8. What is said of the amount of material absorbed and secreted?
9. What is remarked of the growth and decay in the living body?
10. What of the changes of life and death?

SECTION IX.

ANATOMY OF THE RESPIRATORY SYSTEM.

1. **The Respiratory system** consists of the larynx, the trachea, and the lungs; together with the thorax, and the muscles used in breathing.

2. **The Lar'ynx** is situated below the root of the tongue and the hyoid bone, and at the top of the trachea. It opens into the pharynx above and the trachea below; and it produces the prominence in the middle of the neck, called "Adam's apple." The larynx is composed of the thyroid, the cricoid, and the arytenoid cartilages, and the epiglottis.

3. **The Thy'roid cartilage** is the largest, and is situated at the upper front part of the larynx. It consists of two quadrilateral, wing-like plates, which unite in front, and diverge behind.

Fig. 37.

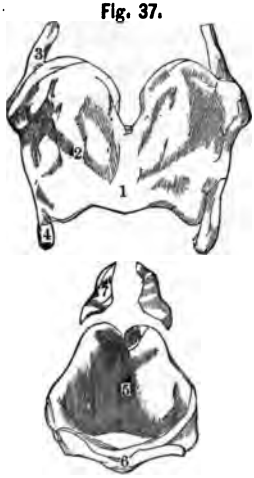


Fig. 38.

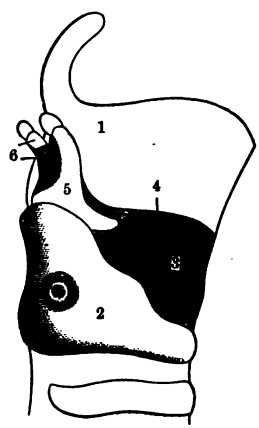


Fig. 37. A FRONT VIEW OF THE CARTILAGES OF THE LARYNX.—1, Thyroid cartilage; 2, its right side; 3, superior horn; 4, inferior horn; 5, posterior portion of cricoid cartilage; 6, anterior portion of cricoid cartilage; 7, the arytenoid cartilages.

Fig. 38. A VIEW OF THE VOCAL MEMBRANE.—1, Left half of the thyroid cartilage: 2 cricoid cartilage; 3, right half of the vocal membrane; 4, left half of the vocal membrane; 5, arytenoid cartilage; 6, arytenoid muscle.

4. **The Cri'coid cartilage** resembles a seal-ring in shape, being a fourth of an inch wide in front, and an inch wide behind. It is situated below the thyroid cartilage, and unites with the first ring of the trachea.

5. **The Aryt'enoid cartilages,** two in number, are small, triangular, and curved, and are situated at the posterior summit of the cricoid cartilage.

6. **The Epiglot'tis** is an oval-shaped plate of fibro-cartilage projecting above the aperture of the larynx, and closing upon it in the act of swallowing. The convex surface of the epiglottis is towards the mouth, and the concave surface towards the larynx. All parts of the larynx are lined with mucous membrane; and all parts, except the epiglottis, are strongly disposed to ossify in advanced life.

7. **The Vo'cal Chords** are composed of elastic tissue, and extend from the front and sides of the upper edge of the cricoid cartilage to the bases of the arytenoid cartilages. The narrow chink, or aperture between the vocal chords, is called the glottis, and is the opening to the larynx.

8. **The Tra'chea,** or windpipe, is a cylindrical tube passing from the larynx down the neck, in front of the œsophagus. It is about four inches long, and three-fourths of an inch in diameter; and at its lower end, opposite the third dorsal vertebra, it divides into two branches, called bronchi, one of which passes to each lung. **The bron'chi** pass behind the large blood-vessels, into the lungs, where they are divided and subdivided; thus growing smaller and smaller, like the branches of a tree, until they reach the air-cells. The smaller divisions are called bronchial tubes.

9. *The trachea and bronchi are composed of cartilaginous rings,* imperfect behind, next to the œsophagus, and connected together by strong fibro-elastic membrane. The trachea, the bronchi, and the bronchial tubes, are all lined with a pinkish-white mucous membrane having a ciliated epithelium. Numerous minute racemose glands are imbedded beneath the mucous membrane, and open upon its free surface.

10. **The Lungs** occupy the greater part of the cavity of the chest, and adapt themselves to its varying size in respiration. They are situated, one on each side; and the two

Fig. 39.

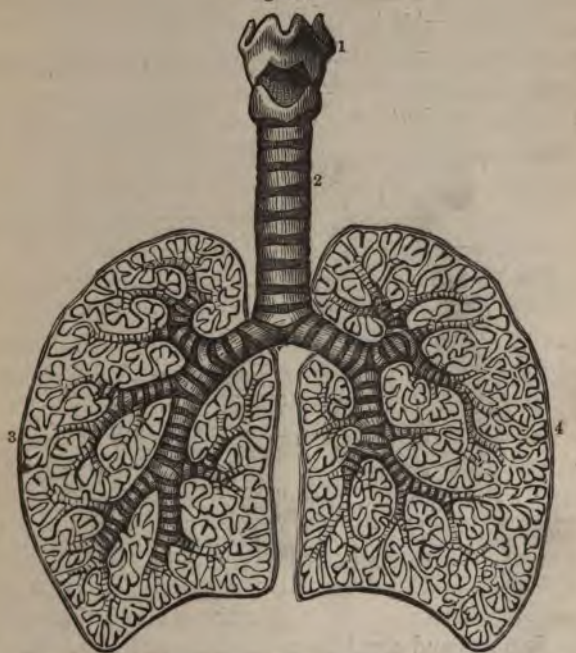


Fig. 39. A View of the Larynx, the Trachea, the Bronchi and their Branches, terminating in the Pulmonary Lobules. —1, The larynx; 2, the trachea; 3, the right lung; 4, the left lung.

are separated from each other by the heart and the great blood-vessels. They are free everywhere, except at their root, where they are attached to the bronchi, to the pulmonary ligaments, and to the pulmonary arteries and veins. The right lung is wider and somewhat larger, although it is shorter than the left one. It is divided into three lobes; but the left lung is divided into only two lobes.

11. *The lungs are composed of a sponge-like substance, of a pinkish-gray color.* They vary much in weight and capacity, according to the age, the sex, the health, and the size of the individual. In the adult, their average weight is about two and a half pounds, and their capacity about three hundred cubic inches. They always contain more or less air after they are once inflated; hence, they are so light as to readily float in water.

12. *The terminal ends of the bronchial tubes are called pulmonary lobules,* and are the one-twelfth part of an inch in diameter. Each lobule consists of a number of cavities, or air-cells, separated from each other by thin partitions. **The air-cells** vary much in size, yet they approach an average diameter of about the one-hundredth part of an inch. They are surrounded by a fine network of capillary blood-vessels, and are lined with mucous membrane. Between the lobules there is a large quantity of elastic tissue, which gives firmness and elasticity to the lung structure. The air-cells in the lungs are very numerous, and have been estimated to number six millions; while the whole extent of their free surface, which is in contact with the air, is probably not less than fourteen hundred square feet.

Fig. 40.

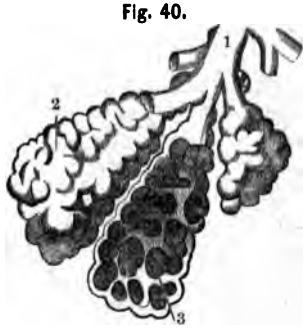


Fig. 40. A VIEW OF AIR-CELLS, MAGNIFIED. — 1, Bronchial tube; 2, portion of lobule with air-cells on its surface; 3, lobule laid open so as to show the air-cells within it.

13. **The Pleura** is a closed sac of serous membrane for each lung. One layer covers the lung while the other lines the walls of the chest, so that the two surfaces rub together during respiration.

QUESTIONS.

SECTION IX.

1. Name the respiratory organs.
2. Describe the larynx.
3. Describe the thyroid cartilage.
4. Describe the cricoid cartilage.
5. Describe the arytenoid cartilage.
6. Describe the epiglottis. With what is the larynx lined?
7. What are the vocal chords? What is the glottis?
8. What is said of the trachea and its branches?
9. Of what are the trachea and bronchi composed? What is said of their lining membrane?
10. Describe the lungs.
11. Of what are the lungs composed? What is said of their weight?
12. Describe the pulmonary lobules and air-cells? What is said of the number and the extent of the air-cells?
13. Describe the pleura.

SECTION X.

PHYSIOLOGY OF THE RESPIRATORY SYSTEM.

1. **The Lar'ynx** performs a double function; one part being to produce the voice, and the other to assist in the respiration. **The voice** is produced by the vocal chords. When they are in a relaxed condition, during expiration, no sound except that of the air gently passing through the larynx is heard; but when the chords are made tense and drawn closely to each other, so as to diminish the size of the aperture, the air is made to vibrate in passing through it, and these vibrations produce the voice.

2. The different *notes* of the human voice, in singing, are produced by the changes in the length and the tension of the vocal chords, and in the narrowness of the glottis. During the production of low notes, the chords are longer and looser and the glottis wider than when the notes are of

higher pitch. It is estimated that the vocal chords in a human voice of ordinary range are capable of two hundred and forty different degrees of tension.

3. *The strength of the voice* depends upon the size of the chest and of the muscles used in speaking. The *pitch* depends upon the length, breadth, and thickness of the vocal chords. These are greater in man than in woman; hence, his voice is bass or tenor, while her voice is contralto or soprano. The *tone* depends upon the size and shape of the vocal organs. In man these are large and coarse, producing a coarse voice; in woman they are smaller, producing a finer and softer voice.

4. **Articulation,** or the formation of the voice into vowel and consonant sounds, so as to produce distinct syllables and words, is made by the throat, the palate, the tongue, the teeth, and the lips, which act in conjunction with the vocal organs of the larynx.

5. *The respiratory movements in the larynx co-operate with those of the chest,* so that the size of the glottis is alternately enlarged and contracted. During the inspiration, the glottis opens and permits the air to pass freely into the trachea; but during the expiration, it relaxes and the air is forced out through it. The inspiratory movements of the glottis are active, requiring an effort to open the aperture; but the expiratory movements are passive, and all the movements correspond with those of the chest, both in time and intensity. **The Epiglot'tis** stands as a sort of guard over the glottis, so as to prevent the entrance of food and other foreign substances into the respiratory passages, where they would be a source of irritation.

6. By the co-operation of the larynx with the lungs, various sounds, such as yawning, sighing, sobbing, crying, laughing, sneezing, and coughing, are produced. *Yawning* occurs from want of fresh air, and often from irritation; *sighing* from depressed feelings, or the want of fresh air; *sobbing and crying* mostly come from emotions of sadness, and *laughter* from emotions of joy; *sneezing and coughing*

are caused by irritation in the air-passages of the lungs, and are but the sudden efforts made for the expulsion of all offending matter.

7. **Respiration** is the breathing of air into and out of the lungs. This is called inspiration and expiration, and is the process by which the venous blood is changed into arterial blood, and is thereby fitted to supply the wants of the system. During *inspiration* the lungs are expanded, and the trachea, the bronchial tubes, and the air-cells, are all filled with air. During *expiration* the lungs are contracted, and a portion of the air in them is expelled. In the adult man, the average number of respirations is *eighteen* in a minute; but they are rather more frequent than this in women and in children.

8. *The average quantity of air taken into the lungs* at each inspiration, and, therefore, expelled at each expiration, is estimated to be about twenty cubic inches; hence, several respirations are required to change the whole of the air in the lungs. At the average of eighteen respirations, the quantity of air taken into the lungs amounts to three hundred and sixty cubic inches in a minute, 21,600 cubic inches in an hour, or *three hundred cubic feet* in twenty-four hours.

9. *The air is composed of three gases; oxygen, nitrogen, and carbonic acid gas.* In one hundred cubic inches of air, there are nearly twenty-one cubic inches of oxygen, seventy-nine cubic inches of nitrogen, and only the one-twentieth of a cubic inch of carbonic acid. The proportion of these gases as they are mixed in the air is exactly suited to the wants of the human being; and they can neither be increased nor diminished without being followed by injurious results.

10. The air, when taken into the lungs, has a portion of its oxygen absorbed by the blood, and receives carbonic acid, and a small amount of water from the blood in return; hence, the same air should not be breathed a second time.

11. *Pure oxygen is highly injurious and even fatal to human life.* By it the vital functions are stimulated, the respiration and circulation increased, and insensibility gradually comes

on so that death occurs in from six to twelve hours. When the amount of oxygen is decreased, the venous blood remains to a greater or less degree unchanged, and the energies of the system are depressed. When one-half of the oxygen in the air is removed, the amount left will not support life in man.

12. *The quantity of oxygen taken from the air* during each respiration, and, therefore, absorbed by the blood, is about one cubic inch, which amounts to *seventeen and a half cubic feet* in twenty-four hours, or to rather less than one and a half pounds.

13. *The quantity of carbonic acid given off by the lungs*, and, therefore, absorbed by the air, at each respiration, is, on an average, nearly one cubic inch, and in twenty-four hours amounts to about *fourteen cubic feet.* The amount of carbonic acid given off by the lungs varies considerably with the age, the sex, the size, and the health of the individual. In man, the quantity exhaled is nearly twice as great as in woman.

14. *The amount of carbonic acid continues to increase during childhood and youth.* In adult life it is more or less stationary, until the fortieth year, after which it diminishes until the close of life. Active exercise increases the carbonic acid from the lungs, so that it is one-third greater then than when the body is at rest. Food generally increases the quantity, and most drinks have the same effect. Tea, coffee, and alcoholic liquors, produce their effects very quickly, but they seldom last more than half an hour.

15. *The amount of carbonic acid exhaled from the lungs is much less during the night than during the day.* The respiration is slower at night, and there is less muscular action, so that only one-half or two-thirds as much is exhaled during sleep as when awake. The quantity is also diminished in all organic diseases of the lungs, and in low forms of fever where it is sometimes reduced one-half; but it is mostly increased in diseases of the skin, and, in cases of small-pox, it is nearly doubled.

16. *The air in the air-cells of the lungs is separated from the blood in the capillaries by a thin membrane.* Through this membrane the oxygen passes from the air to the blood, and the carbonic acid and vapor of water pass from the blood to the air. The oxygen obtained by the blood is carried away to the tissues, and by them appropriated to their own use. The carbonic acid is mostly formed from the disintegration of the tissues, and is carried by the venous blood to the lungs. Both the oxygen and the carbonic acid are absorbed by the blood globules, and are conveyed by them in the form of a solution, and not a chemical combination; hence, the changes in the color of the blood are produced by the action of these gases on the blood globules.

17. When the carbonic acid in the air is increased to ten per cent., or when the oxygen is decreased to ten per cent. of its entire volume, the air is then unfit for breathing, and cannot sustain life. As the carbonic acid is increased, and the oxygen is decreased, with every respiration, it has been estimated that each individual will, on an average, render *about eight cubic feet of air unfit for breathing in every minute,* or four hundred and eighty cubic feet in every hour. When less than this amount of fresh air is supplied, more or less injury must result.

18. *A small quantity of animal matter, in a gaseous form, is exhaled with the breath.* It is this which causes the heavy and oppressive odor of a badly ventilated room in which several persons are breathing. This animal matter is probably one of the most injurious of the exhalations from the lungs.

QUESTIONS.

SECTION X.

1. What double function is performed by the larynx? How is the voice produced?

2. How are the different notes of the human voice produced? Of how many degrees of tension are the vocal chords capable?

3. Upon what does the strength of the voice depend? The pitch? The tone?

4. How are these sounds formed into distinct words?

5. With what do the respiratory movements in the larynx co-operate? What is the function of the epiglottis?

6. What sounds may be produced by this co-operation of the larynx with the lungs? What cause these sounds?

7. Define respiration. What changes occur during respiration? How often do we breathe?

8. What is remarked of the quantity of air needed in respiration?

9. What is said of the composition of the atmosphere?

10. What change takes place in the air during respiration?

11. How does pure oxygen affect the system? How does a decrease of oxygen affect the system?

12. How much oxygen is absorbed by the lungs?

13. How much carbonic acid is given off from the lungs?

14. What conditions cause an increase in the amount of carbonic acid exhaled from the lungs?

15. What cause a decrease in the amount exhaled?

16. What separates the air in the lungs from the blood? What gases pass through this membrane? What is remarked of the oxygen and the carbonic acid in the blood?

17. When is the air unfit for breathing? What amount of fresh air is needed to supply each individual?

18. What is said of the animal matter exhaled from the body?

SECTION XI.

ANIMAL HEAT.

1. *All substances, not living, vary in temperature,* according to the atmosphere in which they are placed; but living things have the power, to a greater or less degree, of resisting the influence of both heat and cold. This power is feeble in plants, but it is stronger in animals; and, as we ascend in the scale, we find each species to possess the inherent power of maintaining a temperature peculiar to itself. The heat which is produced in the body so as to maintain this temperature, is known as **Animal Heat.**

2. **Animals** may be divided according to the temperature of their bodies, into two classes; called the warm-blooded animals and the cold-blooded animals. *The birds and the mammals, including man, are warm-blooded,* and maintain nearly a uniform temperature; but the *fish and the reptiles are cold-blooded,* and their temperature varies very much with the air or the water in which they live.

3. *The range of temperature in mammals* is from 97° to 105°; while, *in birds,* it varies from 100° to 111°. In the Arctic fox, the temperature has been found to be 107° while in an atmosphere of only 14°. In the common fowl, it ranges from 107° to 110°, according to the climate; and in the swallow, it reaches 111°, which is higher than the temperature of any other living creature.

4. **The tissues** of the human body, mostly range in temperature from 98° to 100°, while **the blood** varies from 100° to 102°. The temperature in the thorax is about 100°, under the tongue it is 98°, and in the axilla, 96°, while the hands and feet are from 4° to 6° cooler. When from any cause the temperature of the human body is *raised* to 110°, or is *lowered* to about 80°, the individual becomes insensible, and death soon follows.

5. The temperature of the human body is the same at all ages; but the very young and the very old cannot resist the depressing effects of cold so well as the middle-aged. The heat of the body may be increased 1° or 2° by exercise; and it is reduced 1° or 2° during sleep. The temperature varies much in disease; for while it is 110° in lock-jaw, it is often below 80° in cholera.

6. The heat of the body is probably produced in the tissues by a long series of chemical changes which take place during the process of nutrition; but these changes are not well understood.

7. In the coldest weather of winter the body generates so much animal heat that the temperature of the internal organs is kept up to the natural standard. In the lower ani-

mals, the heat is maintained in the body by means of the natural covering of hair or wool; but *man is forced to clothe himself in woollen goods or furs* so as to preserve an equable temperature. He also resorts to artificial heat, and warms his places of abode so as to make himself comfortable.

8. In the summer season, although the weather is warm, the temperature of the body does not rise above 100°. Its warmth is regulated then, not by artificial heat or by clothing, but by means of the *perspiration.* Whenever the temperature is increased by the warm weather, or by exercise, the sweat glands pour out the perspiration, in increased abundance, upon the surface of the body. This perspiration is evaporated, and thus the temperature of the body is prevented from rising above the natural standard.

9. *Evaporation is a cooling process;* and the heat of the body may be rapidly reduced by the evaporation from its surface. On this account it becomes a fruitful source of *colds.* When the body is in a state of perspiration from any cause, and a part of the clothing be removed, or we remain in a draught of air, the evaporation will take place so rapidly as to reduce the body below its natural temperature, and cold or other sickness will almost surely result; but if an additional garment be put on, so that the cooling goes on more slowly, injury will seldom follow.

QUESTIONS.

SECTION XI.

1. What is remarked of the temperature of substances?
2. How may animals be classified? What is said of each class?
3. What of the range of temperature in mammals and in birds?
4. What of the temperature of the human body?
5. How may the temperature of the body be changed?
6. How is the heat of the body produced?
7. How is the heat of the body maintained during the winter season?
8. How is it reduced during the summer season?
9. What is said of evaporation from the surface of the body?

CHAPTER IV.—Sensory Apparatus.

SECTION I.

ANATOMY OF THE NERVOUS SYSTEM.

1. **The Ner'vous System** may be divided into two systems, **the cerebro-spinal system,** consisting of the brain, the spinal cord, and the nerves given off by them to all parts of the body; and **the sympathetic system,** composed of nerves and ganglia, mainly distributed to the viscera of the body.

General Character and Structure of the Nerves.

2. The nervous system is composed of two kinds of nerve matter; called the *white substance and the gray substance.* The brain has the gray substance for its exterior, and the white substance for its interior; but the spinal cord has the white substance for its exterior, and the gray substance for its interior.

3. **The white substance** is composed of transparent tubular fibres, of various sizes, and so soft as to be broken into fragments by the slightest violence. These are called white nerve-fibres, and average about the $\frac{1}{6000}$ of an inch in diameter.

4. **The gray substance** is composed of nerve-fibres, nerve-cells, nuclei, and granular matter. The gray nerve-fibres are similar in structure to the white; but in size are not more than two-thirds of their diameter. The nerve-cells

have a delicate wall, with granular contents, and one or more nuclei, and are probably the most important element of the gray substance. The granular matter furnishes a kind of matrix, in which the nerve-cells and numerous nuclei are imbedded.

5. **The Cer'ebro-spi'nal** nerves are given off from the brain and spinal cord, in pairs, and are thence distributed to the body. At their origin, they appear like white cylindrical cords; and they give off branches in their course until they are finally reduced to fine filaments in the various tissues and organs. The nerves, supplying an organ, are generally found in company with the lymphatics and the blood-vessels of that organ.

6. *The nerves are composed of bundles of nerve-fibres,* arranged nearly parallel with each other, and enclosed in a sheath of connective and elastic tissue, called the neurilem'ma. The nerve-fibres of these nerves are similar to those of the white substance of the brain, except that they are larger. Each nerve-fibre remains undivided from its origin, where it connects with the brain, or spinal cord, to its termination, where it ends in the tissues.

7. A nerve is said to *arise* by one root, when all its fibres come from one point; and from two or more roots, when its bundles of fibres come from two or more points. The manner of the *termination* of the nerves is for the most part unknown. Three modes of termination, however, have been detected.

8. First, by the **Pacin'ian corpuscles** found in the fingers and toes. They consist of concentric layers of fibrous tissue, forming a cavity, which contains a single nerve-fibre. 2d, By the **Tac'tile corpuscles** found in the papillæ of touch in the hands and feet. They consist of a single layer of membrane, forming a cavity, which contains from one to four nerve-fibres. 3d, By **Spher'ical corpuscles,** containing one or two nerve-fibres, and found in the eyeball and the tongue.

9. The nerves of the **Sympathet'ic System** are mostly

reddish-gray, or grayish-white, but a few of the largest trunks are white. They are connected with numerous ganglia; hence, have been called the *ganglion'ic system.* They are composed of two kinds of nerve-fibres; the white fibres, which are mostly found in the white trunks, and are much finer than those of the cerebro-spinal system; and the gray fibres, which are most numerous in the reddish-gray, and the grayish-white nerves, and occur in the form of bands.

10. **The Gan'glia** are roundish bodies, which vary much in form, and appear like knots or swellings in the course of the nerves. They are regarded as sources of nerve power; and are called *nerve centres,* the same as the brain and spinal cord. They consist of nerve-cells, similar to those of the gray substance of the brain, which are imbedded along with the nerve-fibres in the connective tissue. Some of the nerve-fibres in the ganglia are joined to the cells, while others are without any such attachment.

The Cerebro-Spinal System.

11. **The Cer'ebro-spi'nal system** consists of the brain, the spinal cord, and the nerves originating from them. The brain and spinal cord are in two symmetrical halves, which are united in the median line by commissures of nerve matter.

12. **The Brain** is the mass of nervous matter which completely fills the cavity of the cranium, and is the seat of the sensitive and intellectual faculties. The size and weight of the brain varies with the age, the sex, the race, and the individual. It is largest in the white race; averaging nearly fifty ounces, avoirdupois, in the man, and forty-five ounces, in the woman. The brain of the human species is larger than that of any other species of animals, except elephants and whales. It is divided into four parts; the cerebrum, the cerebellum, the pons, and the medulla oblongata.

Fig. 41.

Fig. 41. A Back View of the Brain and of the Spinal Cord and its Branch

13. **The Cer'ebrum** is the largest division of the brain, and comprises about six-sevenths of its entire mass. It extends the whole length and breadth of the upper part of the brain, and conforms in shape exactly with the cavity of the

Fig. 42.

Fig. 42. THE BASE OF THE BRAIN. — 1, The anterior lobe of the cerebrum; 2, the middle lobe; 3, the posterior lobe; 4, the anterior end of the great longitudinal fissure; 5, the end of the medulla oblongata where it joins with the spinal cord; 6, the hemispheres of the cerebellum; 7, the pons; 8, the sylvian fissure; 9, the crura of the cerebrum; 10, the medulla oblongata; 11, the olfactory nerve; 12, optic nerve; 13, oculo-motor nerve; 14. pathetic nerve; 15, trifacial; 16, abducent; 17, facial; 18, auditory; 19, glosso-pharyngeal; 20, pneumo-gastric; 21, accessory; 22, hypoglossal nerve.

skull. The cerebrum is divided into two hemispheres, by the *great longitudinal fissure* in its upper part. The base, or lower part of each hemisphere, is separated into three lobes; the anterior lobe, resting above the position of the

orbits; the middle lobe, occupying the middle portion of the brain; and the posterior lobe, resting above the cerebellum, at the back part of the skull.

14. The external surface of the hemispheres is everywhere raised up into *convolutions* which are separated from each other by winding fissures. These convolutions are nearly uniform in diameter; but their course varies in the two hemispheres, and in different individuals.

15. **The Cer'ebrum** is composed of two kinds of nerve substance; a gray substance, which occupies its exterior in the form of a layer of uniform thickness, following the course of all its convolutions, and extending over the whole of its surface; and a white substance, which fills all its interior portion.

16. At the bottom of the deep longitudinal fissure, which

Fig. 43

Fig. 43. A VIEW OF THE LEFT HALF OF THE BRAIN.—1, Medulla oblongata; 2, pons; 3, crus of the cerebrum; 4, arborescent appearance of the cerebellum; 5, left hemisphere of the cerebellum; 6, left hemisphere of the cerebrum; 7, corpus callosum; 8, pellucid septum; 9, fornix; 10, anterior crus of the fornix; 11, pineal gland; 12, optic nerve; 13, oculo-motor nerve; 14, fourth ventricle; 15, quadrigeminal body; 16, canal from the third to the fourth ventricle; 17, anterior lobe of the cerebrum; 18, its middle lobe; 19, its posterior lobe; 20, the commencement of the spinal cord.

separates the cerebrum into two hemispheres, is a convex body of white nerve matter, called the *cor'pus callo'sum.* It is about three inches long, and three-fourths of an inch wide, and unites the two hemispheres together. It is transversely striated, but has some longitudinal fibres along the median line.

17. Beneath the corpus callosum are two cavities, called the *lateral ventricles.* Each of these cavities extends into the three lobes of the cerebral hemispheres, by prolongations, named *horns;* and the two cavities are separated from each other by a thin partition of nerve matter, called the *pellu'cid sep'tum.* Beneath the lateral ventricles, is a thin layer of white nerve matter, named the *for'nix;* and beneath the fornix, is a narrow triangular cavity, called the *third ventricle* of the brain. Below the third ventricle, and forming its floor, from before backward, are the *op'tic com'missures,* uniting the optic tracts, and giving rise to the optic nerves; the *infundib'ulum,* a funnel-shaped body of gray substance; the *mam'millary eminences,* which are two, small, white, spherical bodies; the *posterior perforated space;* and the *cru'ra of the cer'ebrum,* which are two large bodies diverging in front of the pons, and entering the cerebral hemispheres.

18. Four eminences of white substance, called the *quadrigem'inal bodies,* are situated behind the third ventricle, and are separated from the cerebral crura by the passage leading from the third to the fourth ventricle. A small body of gray substance is situated on the two anterior eminences of the quadrigeminal bodies, and is called the *pine'al gland.* It is remarkable for containing grains of a sand-like nature.

19. **The Cerebel'lum** is next to the cerebrum in size, and comprises about one-eighth of the entire mass of the brain. It is divided into two hemispheres by a deep groove, called the *valley.* The exterior of the cerebellum is composed of gray substance, and is raised into convolutions, similar to those of the cerebrum, while the interior is composed of the

white substance. The arrangement of the gray and the white substance, gives an arborescent appearance to the cerebellum, when cut vertically.

20. **The Pons** is a small body of white substance, situated in front of the cerebellum, and extending, like a bridge, from one hemisphere to the other. The lower portion of the pons is composed of transverse nerve-fibres, which diverge at each side, forming the crura of the cerebellum, and passing into its hemispheres.

21. **The Medul'la Oblonga'ta** is about one inch long, and is the smallest of the divisions of the brain. It is composed of white nerve-substance, and is situated in front of the cerebellum, beneath the pons. It is divided by the anterior and the posterior median fissure into two lateral portions, which are further divided into the *pyramidal, olivary, and restiform bodies, and the posterior pyramids.* Fibres of nerve-matter extend from the medulla oblongata behind the pons, and emerge from its upper part, forming the crura of the cerebrum, which, therefore, connect the spinal cord with the brain.

22. **The Spinal Cord** occupies the spinal canal, and furnishes nerve power to the skin and to the muscles of the neck, the trunk, and the extremities. It connects with the medulla oblongata, at the occipital foramen, and it extends to the lower part of the last lumbar vertebra. It is from fifteen to eighteen inches long, and weighs about one and a half ounces. The spinal cord is somewhat cylindrical in form, but is flattened from before backward. It presents two enlargements, called the cervical enlargement, and the lumbar enlargement, which correspond with the large nerves, emanating from these portions, to be distributed to the upper and the lower limbs.

23. The spinal cord is divided by the anterior and the posterior median fissures into two symmetrical halves; and these are each subdivided into three columns, *the anterior, the lateral, and the posterior columns,* by the anterior and

the posterior lateral fissures. The spinal nerves originate from each side of the cord, by anterior and posterior roots, which rise from the corresponding lateral fissures.

24. *The brain and the spinal cord are enveloped by three membranes;* the dura mater, the arachnoid, and the pia mater. **The Du'ra Ma'ter** of the brain is its exterior membrane, and is composed of fibrous tissue. It is very tough, and consists of two layers; the outer one corresponding with the periosteum of the bones, and the inner one with the dura mater of the spinal cord.

25. **The Arach'noid** is a delicate serous membrane, closely lining the dura mater, and loosely attached to the pia mater; thus forming a cavity called the subarachnoid space. This cavity usually contains several ounces of a serous fluid, secreted by the arachnoid membrane.

26. **The Pi'a Ma'ter** is a delicate membrane, closely investing the brain and the spinal cord. It is composed of numerous blood-vessels, with interlacing bundles of fibrous tissue; and it extends into all the fissures of the brain.

27. **The Cra'nial** nerves, or nerves originating in the brain, consist of twelve pairs, named from before backward.

28. **The Olfac'tory,** or first pair of nerves, are situated beneath the anterior lobes of the cerebrum, and are distributed to the mucous membrane of the upper part of the nose. They are *nerves of smell.*

29. **The Op'tic,** or second pair of nerves, diverge from the optic commissure, and pass into the orbits where they are distributed to the retina of the eyeball. They are *nerves of vision.*

30. **The Oc'ulo-mo'tor,** or third pair of nerves, originate from between the crura of the cerebrum, and in front of the pons, and are distributed to the muscles moving the eyeball. They are *motor nerves.*

31. **The Pathet'ic,** or fourth pair of nerves, originate from behind the quadrigeminal bodies, and are distributed to the superior oblique muscle of the eye. They are ***motor nerves.***

32. **The Trifa'cial,** or fifth pair of nerves, arise by two unequal roots from each side of the pons. The large root terminates in the semilunar ganglion from which emanate three nerves: 1st, **The Ophthal'mic nerve** distributed to the lachrymal gland, the skin and muscles of the forehead, the iris, the eyelids, and the skin of the nose; 2d, **The Supe'rior Max'illary nerve** distributed to the cheeks, the nose and upper lip, the upper teeth, the mouth, and the pharynx; 3d, A branch which unites with the small root of the trifacial nerve, and forms the **Infe'rior Max'illary nerve,** which is divided into two branches, one going to the muscles that move the jaw, and the other to the external ear, the tongue, the lower teeth, the chin, and the lower lip. The large root is *sensitive*, and also the *nerve of taste;* and the small root is *motor.*

33. **The Abdu'cent,** or sixth pair of nerves, arise between the pons and the medulla oblongata in front, and are distributed to the external straight muscles of the orbits. They are *motor nerves.*

34. **The Fa'cial,** or seventh pair of nerves, arise between the pons and the medulla oblongata at the sides, and are distributed to the muscles of the ear, the upper part of the neck, and to the temples, cheeks, forehead, eyelids, nose, lips, and chin. These are *motor nerves,* and they produce all the emotional changes in the expressions of the face.

35. **The Au'ditory,** or eighth pair of nerves, originate from the sides of the medulla oblongata, and are distributed to the labyrinth of the ear. They are *nerves of hearing.*

36. **The Glos'so-pharyn'geal,** or ninth pair of nerves, arise by five or six roots from each side of the medulla oblongata, and are distributed to the lining membrane of the internal ear, the tonsils, the muscles, and mucous membrane of the pharynx, and the root of the tongue. They are *sensitive nerves,* and also *nerves of taste.*

37. **The Pneumogas'tric,** or tenth pair of nerves, arise by from ten to fifteen roots from each side of the medulla oblongata, descend through the neck and thorax, and are

distributed to the larynx, the trachea, the lungs, the heart, the pharynx, the œsophagus, and the stomach. They are *sensitive nerves.*

38. **The Acces'sory,** or eleventh pair of nerves, arise by several roots from the spinal cord, and the upper parts of the medulla oblongata, and are distributed to the larynx, and to the muscles of the neck, and the upper back part of the chest. They are *motor nerves,* and preside over the vocal movements of the glottis.

39. **The Hypoglos'sal,** or twelfth pair of nerves, arise from each side of the medulla oblongata, and are distributed to the muscles of the tongue. They are the *motor nerves* of the tongue.

40. **The Spi'nal nerves** number thirty-one pairs. Each nerve originates by an anterior and a posterior root, from

Fig. 44.

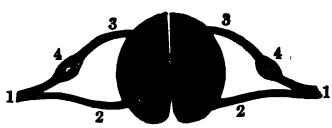


Fig. 45.

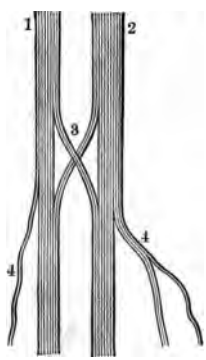


Fig. 44. A Transverse Section of the Spinal Cord.—1, The spinal nerve of the right and of the left side; 2, the anterior root; 3, the posterior root; 4, the ganglion of the posterior root.

Fig. 45. Anastomosis between two Nerves.—1, 2, Nerve fibres; 3, anastomosis between two nerves; 4, a branch from a nerve.

the corresponding lateral grooves of the spinal cord. The posterior root is smaller than the anterior root, and is provided with a *small ganglia.* Near this ganglia, the two roots

unite by an intermixing of their fibres, and form a common trunk, which is afterwards separated into an anterior and a posterior branch, each of which is composed of fibres from both roots. The anterior branch supplies the front parts, and the posterior branch the back parts of the body.

41. *The spinal nerves anastomose very much with each other*, with some of the cranial nerves, and with the nerves of the great sympathetic system, forming networks, called *plexuses;* and indeed almost all nerves anastomose more or less with each other, thus presenting a most intricate system of study. Nerves are said to anastomose when some of their fibres pass to other nerves.

The Sympathetic System.

42. The nerves of the **Sympathet'ic System** are usually much smaller than those of the cerebro-spinal system, and are much more numerously provided with ganglia. The sympathetic system consists of two nerves, containing many ganglia. They extend the whole length of the spinal column, one nerve being on each side.

43. *The number of these ganglia* on each side of the spinal column, corresponds very nearly with the number of spinal nerves. The ganglia and the spinal nerves are united by short, narrow cords, composed of nerve-fibres; thus the two systems are closely connected together.

44. Many of the nerves from this system follow the course of the blood-vessels; but by far the greater number contribute to form *three plexuses:* the **Car'diac,** in the thorax; the **So'lar,** in the abdomen; and the **Hypogas'tric,** in the pelvis. These give off many smaller plexuses, which form networks around the larger blood-vessels, extending from their origin in the aorta to their termination in the different organs.

QUESTIONS.

SECTION I.

1. Define the two systems into which the nervous system is divided.
2. Name the two kinds of nerve-matter. How are they arranged in the brain and in the spinal cord?
3. Describe the white nerve-substance.
4. The gray nerve-substance.
5. What is said of the cerebro-spinal nerves?
6. Of what are the nerves composed? What is said of each nerve-fibre?
7. What is said of the origin of the nerves? What of their termination?
8. Describe the pacinian corpuscles. The tactile corpuscles. The spherical corpuscles.
9. Describe the nerves of the sympathetic system.
10. Describe the ganglia.
11. Of what does the cerebro-spinal system consist?
12. Describe the brain. What are its divisions?
13. Describe the cerebrum.
14. What is said of the external surface of the cerebrum?
15. Describe the gray and the white substance in the cerebrum.
16. Describe the corpus callosum.
17. Describe the cavities, commissures, and other parts at the base of the brain.
18. Describe the quadrigeminal bodies. The pineal gland.
19. Describe the cerebellum.
20. Describe the pons.
21. Describe the medulla oblongata.
22. Describe the spinal cord.
23. How is the spinal cord divided? From what do the spinal nerves originate?
24. Name the membranes of the brain. Describe the dura mater.
25. Describe the arachnoid membrane.
26. Describe the pia mater.
27. Of what do the cranial nerves consist?
28. Describe the olfactory nerves.
29. The optic nerves.
30. The oculo-motor nerves.
31. The pathetic nerves.
32. The trifacial nerves.
33. The abducent nerves.
34. The facial nerves.
35. The auditory nerves.
36. The glosso-pharyngeal nerves.

37. Describe the pneumogastric nerves.
38. The accessory nerves.
39. The hypoglossal nerves.
40. The spinal nerves.
41. What is said of the anastomoses of nerves?
42. Describe the sympathetic nerves.
43. What is remarked of the ganglia and the spinal nerves?
44. What is said of the plexuses of nerves?

SECTION II.

PHYSIOLOGY OF THE NERVOUS SYSTEM.

1. *The functions of the Nervous System are neither physical nor chemical in their nature.* It does not act for itself, like the heart, the lungs, and other organs; but its purpose is to influence the action of those organs.

2. **The Cer'ebro-spi'nal system** presides over the locomotory, respiratory, sensitive, and intellectual functions of the body. **The Sympathet'ic system** presides over the vegetative or nutritive functions of the body. As we ascend in the scale of animals, the cerebro-spinal system increases in size in proportion to their intelligence, sensation, and power of motion; man being the highest in the scale. The sympathetic system, however, is more highly developed in some of the lower animals than it is in man. Its development corresponds with the development of the digestive organs; and man does not present the highest type in this respect.

3. *The entire nervous system consists of nerve centres, nerves, and commissures.* The latter are composed of white nerve-fibres, and serve to connect the hemispheres of the brain; and also the symmetrical halves of the spinal cord.

4. *Every collection of gray nerve-matter is called a nerve-centre;* hence, the brain, the spinal cord, and the ganglia, are all nerve-centres. They receive impressions brought to them by certain nerves, and they send out expressions by

other nerves. Nerve-power thus originates in the nerve-centres; but the transmission of this power belongs exclusively to the nerves. How this nerve-power is produced in the nerve-centres, is entirely unknown; yet, that it is so produced is evident, because neither motion nor sensation can be excited in a nerve, unless it communicates with a nerve-centre.

5. *All communication between two organs in the body must be through a nerve-centre;* thus, the sensations produced by a foreign substance in the glottis are carried to a nerve-centre, which immediately reacts and sends a power that calls into activity the various muscles needed in its expulsion. This is called the *reflex action* of the nervous system; because information is first sent inward to the nerve-centre, and is then reflected from that centre to its appropriate destination.

6. *The nerves are organs of communication* connecting the nerve-centres with the tissues and organs of the system. They are endowed with a peculiar function, and when this is excited at one extremity, it extends throughout the entire length, producing its effects at the opposite extremity. Thus, when nerves distributed to the muscles are excited at their origin, in the brain, by the impulse of the will, they produce a contraction of the muscular fibres at their extremity; and when nerves of sensation are excited at their extremity, in the skin, they produce a corresponding sensation at their origin in the brain. How this power is conveyed is not known, as no visible change takes place in the nerve-fibres.

7. *All nerve-power in the body shows itself in one of two distinct forms; either as sensibility,* or power of sensation, *or as excitability,* or power of motion. Hence, there are two sets of nerves or nerve-fibres; one to extend from the sensitive surfaces of the body to the nerve-centres, to carry impressions inward, and the other to extend from the nerve-centres to the muscles, to carry impressions outward. The first are called *sensitive nerves,* and the second are called *motor*

nerves. Both sets of nerves have the function of *irritability;* but in the sensitive nerves, it produces sensation, and in the motor nerves, it produces movement.

8. *Nervous irritability is inherent in the nerve, as a special endowment;* but the power of this irritability is manifested only in the organ to which the nerve is distributed. It may be exhausted by continued irritation, but the power will be regained by rest. *The shock,* from a severe injury, often destroys or suspends the irritability of the nerves, so that the patient experiences no pain, until reaction takes place, which may not be until several hours have elapsed.

9. *Each organ and tissue of the body is endowed with a function peculiar to itself,* and this function is called into action by the irritability of the nerves; thus, when a nerve distributed to a gland is excited, it produces increased secretion, and when a nerve to a muscle is excited, it causes contraction of the fibres. How the nerves operate to excite these functions cannot be explained.

10. The function of many of the organs may be called into activity in an indirect way, as by the *sympathy* which one organ of the body has for another organ. Thus, when light falls upon the retina, it causes a contraction of the pupil of the eye; and when a foreign substance is lodged in the glottis, it excites various muscles, so as to produce coughing. This sympathetic connection between the different organs, so necessary to our existence, is established by means of the nervous system.

11. *When a nerve-fibre is cut or broken, its function ceases;* but it has the power of re-uniting, and in this way its function may be recovered. In man, several weeks, and even months, are required to complete this process; but it is usually accomplished in a few days, in the young of the inferior animals.

12. The spinal cord sends out nerves to supply the neck, the trunk, and the extremities, and these embrace the skin and the muscles of about nine-tenths of the whole body. All

these parts are endowed with the power of sensation, and the power of motion, both of which depend directly or indirectly on the nerve-centres in the spinal cord.

13. *The power of sensation enables us to receive impressions from external things*, by which we obtain some information in regard to their qualities, and the effect they may have upon our systems; thus, when a foreign substance is brought in contact with our bodies, we learn whether it is hot or cold, rough or smooth, hard or soft, large or small, at rest or in motion, and many other things in regard to it. This power of sensation depends upon the sensitive nerves, and varies in acuteness according to their distribution; the lips, the tip of the tongue, and the ends of the fingers being more sensitive than other parts of the surface of the body.

14. *When this foreign substance is of such a nature as to injure the skin or its nerves, the sensation of pain is produced.* This sensation of pain is different from the sensitive impressions just mentioned, and seems to take their place in most cases. For instance, we can judge of the temperature of a body that is moderately hot or cold; but when it is hot enough or cold enough to injure the skin, we lose the sense of judging of its temperature, and feel only the pain produced. The sensation of pain may be blunted while we still remain subject to sensitive impressions. *Opium* may lessen the pain from neuralgia in a nerve, while the nerve still remains subject to sensitive impressions; and *ether* may make a person insensible to pain without destroying his consciousness of external things.

15. The various impressions made upon the nerve-centres, through the sensitive nerves, are conveyed by the motor nerves to the proper tissues and organs, so as to excite their functions into activity. The effect of this nervous excitement on a gland, is to increase its secretion; as when food is taken into the mouth, the fact is carried by the sensitive nerves to the brain, and the motor nerves are set at work to excite the salivary glands, which respond by increasing the

amount of saliva. The effect on the lungs is to increase their movement; thus, when more oxygen is needed, the lungs are excited to increased motion, so as to supply it. And the effect on a muscle causes it to contract or relax, so as to correspond with the impressions given.

16. *The nerves of sensation and motion are closely connected,* and their functions are generally impaired or suspended together, as in a fit of fainting, or an attack of apoplexy. Sometimes there is a loss of motion, and not of sensation, as when the muscles of the face are paralyzed; and there may be a loss of sensation, and not of motion.

17. *The spinal nerves arise from the spinal cord by two roots;* the *anterior,* which is exclusively *motor,* and the *posterior,* which is exclusively *sensitive,* in function. In the trunks of the spinal nerves both sets of nerve-fibres, the sensitive and the motor, are mingled together; but in the roots of the spinal nerves, these fibres are separated. Spinal nerves are, therefore, called *mixed nerves,* having both sensitive and motor fibres.

18. *The anterior columns* of the spinal cord, like the anterior roots, are *motor;* and *the posterior columns,* like the posterior roots, are *sensitive. A sensitive impression* made on the skin is carried by sensitive nerves to the posterior columns of the spinal cord, thence to the brain by communicating fibres in the cord. *A motor impression* from the brain is carried along the fibres of the anterior columns of the spinal cord, and passes off by the anterior roots to the nerves by which it is carried to its destination in the tissues or organs.

19. *The motor nerve-fibres of the anterior columns decussate, or pass from side to side, at the lower part of the medulla oblongata;* those of the right side pass to the left, and those of the left side pass to the right. The result of this decussation is, that any injury to one side of the brain, produces loss of motion in the opposite side of the body; thus, injury to the left side of the brain will cause paralysis of the right side of the body. When the anterior columns of the spinal cord

are injured below the medulla oblongata, the effect is shown on the same side as the injury; thus, injury on the left side of the cord, causes a loss of motion in the left side of the body.

20. *The sensitive nerve-fibres of the posterior columns, cross from side to side throughout the entire length of the spinal cord;* hence, any injury to one side of the brain, or to the spinal cord, will produce a loss of sensation in the opposite side of the body below where the injury is received.

21. *A nerve may be irritated anywhere along its course by various means,* such as by heat, cold, or electricity. When the irritation is to a motor nerve, the effect is produced at its termination in the muscle; but when it is to a sensitive nerve, the impression is made upon the brain, and this impression seems to come from the termination of the nerve, and not from the point of irritation. Thus, after an arm is amputated, if the nerve, originally distributed to the fingers, be irritated, the sensation produced upon the brain seems to come from the fingers, and not from the amputated end of the nerve.

22. Although many nerve-fibres are mingled together to form the trunk of a nerve, yet *each fibre remains unbroken from its origin to its termination; and when it is irritated, it acts independently of all other fibres,* and does not communicate its irritability to them. Thus, when a nerve is touched by the point of the finest needle, the impression upon the brain is from that point alone. If this were not so, there would be constant confusion in the sensations and movements of the body.

23. There are other nerve-sensations and movements produced in the body, which have been called *associated sensations, and associated movements;* thus, disagreeable odors and disagreeable sights may produce nausea; the odor of food stimulates the salivary glands and makes the mouth water; tickling the feet causes laughter; and when the extensor muscles contract, the flexor muscles relax — the two movements being associated.

24. *The irritability of the sensitive nerves ceases from without inward;* hence, the external parts of the body may lose their sensibility several hours before death takes place.

25. The brain comprises all that part of the nervous system contained within the cavity of the cranium; and it is the seat of sensation and of motion. *The sensitive portions* of the brain are the posterior parts of the medulla oblongata, and the upper part of the crura of the cerebrum. *The motor portions* are the anterior parts of the medulla oblongata, and the lower part of the crura of the cerebrum. These portions are but a continuation of the spinal cord, and like it are subject to irritability; but all other parts of the brain are destitute of both irritability and sensibility.

26. **The cerebrum** is the seat of the *reasoning or intellectual faculties.* It is the instrument through which the powers of memory, reason, and judgment make themselves manifest. When the cerebrum is imperfect, or is injured in any way, the intelligence of the individual is correspondingly affected.

27. **The cerebellum** is supposed to be the seat of the *associated sensations and movements* of the body. It preserves the unity and harmony of various muscular movements, which are absolutely indispensable to life.

28. **The medulla oblongata** is the nerve-centre presiding over the *respiration.* When it is destroyed, respiration ceases, and death results.

29. *The actions of the cerebro-spinal system may be classed as instinctive and reasoning. The instinctive actions* are such as are performed blindly, and without any reference to experience or judgment. Thus, the feeling of hunger creates a desire for food, and thirst, a desire for drink. The food and the drink are taken instinctively to satisfy the desires, and not from any reasoning of the mind that they are necessary to support life; hence, all animals eat when they are hungry, and drink when they are thirsty, from instinct alone. The bird builds its nest, the honey-bee constructs its cell, the silk-worm spins its coccoon, and the spider its web,

without experience or judgment, and, consequently, without improvement, although centuries have rolled away since God first set these creatures to work.

30. *The actions which result from reasoning, require the co-operation of the cerebrum.* The nature of a sensation must first be comprehended, and its effects be understood, before we can, by our judgment or experience, decide how to act in regard to it. The action does not depend upon the sensation produced in the brain, but upon the reasoning in regard to that sensation, by which the human mind is enabled to adapt means to ends. It is this faculty of reason which makes man the crowning glory of God's creation, in this world, and enables him to profit from the experience of those who have passed away.

31. *The nerves given off by the brain may be divided into three classes;* nerves of special sense, sensitive nerves, and motor nerves.

1. **The nerves of Special Sense** are neither sensitive nor motor, and convey only their special sense of smelling, seeing, or hearing. They are:

The Olfactory, or first pair of nerves.
The Optic, or second pair of nerves.
The Auditory, or eighth pair of nerves.

2. The nerves of motion, called **Motor nerves**, are:

The Oculo-motor, or third pair of nerves.
The Pathetic, or fourth pair of nerves.
The Small root of the fifth pair of nerves.
The Abducent, or sixth pair of nerves.
The Facial, or seventh pair of nerves.
The Accessory, or eleventh pair of nerves.
The Hypoglossal, or twelfth pair of nerves.

3. The nerves of sensation, called **Sensitive nerves**, are:

The Large root of the fifth pair of nerves.
The Glosso-pharyngeal, or ninth pair of nerves.
The Pneumogastric, or tenth pair of nerves.

32. *The motor nerves, originating from the brain, are the*

same in function, as the motor nerves from the spinal cord. They are purely motor at their origin from the brain, but after they leave the cranium they receive fibres, more or less, from the sensitive nerves, and become mixed nerves, having both motor and sensitive fibres mingled in the same trunk.

33. *The sensitive nerves from the brain are capable of sensation,* the same as those from the spinal cord. Each sensitive nerve passes through a ganglion, near its origin, the same as is done by the sensitive roots from the spinal cord, and then receives more or less motor fibres from other nerves. In these respects the functions of the cranial nerves and of the spinal nerves are identical; but the sensitive nerves from the brain also give off nerves of special sense. The large root, from the fifth pair, sends one branch to the tongue, as a nerve of taste; the Glosso-pharyngeal also sends a branch to the tongue, as a nerve of taste; and the Pneumogastric presides over the voice, the respiration, the deglutition, and the digestion in the stomach.

34. The great sympathetic nerve acts with less force and less rapidity than the cerebro-spinal nerves; hence, the internal organs, over which it presides, move very slowly and to a very limited extent, and their sensibility to pain, or to the touch, is scarcely perceptible, except when they are in an inflamed state.

35. *On account of this slowness of movement in the sympathetic system,* internal inflammations are not manifested for some time after the application of the exciting cause; thus, indigestible food remains in the stomach some hours before irritation is produced in that organ; and the effect of exposure to cold or to dampness often is not felt for hours, or even for days afterwards. Because of the slowness in the production of these inflammations, they usually remain a considerable time after the cause is removed.

36. *Three kinds of reflex action take place through the sympathetic system:* 1st, The reflex action which takes place through its ganglia, from one organ to another; thus, food

in the intestinal canal causes a peristaltic movement in its muscular coat, and food in the small intestine excites the lymphatic and the capillary vessels to increased absorption. 2d, The reflex action from the sensitive surfaces to the internal organs; thus, disagreeable sights or odors may produce nausea, and mental impressions may disturb the circulation and digestion, the same as joyful or sorrowful news often takes away the appetite. 3d, The reflex action from the internal organs to the sensitive surfaces; thus, indigestible food in the stomach may cause convulsions, or even temporary blindness.

37. *The activity of the organs of circulation, digestion, and absorption, depends in a measure upon each other.* There is a sympathy of feeling among them by which their functional activity is regulated, and this sympathetic feeling is presided over by the sympathetic system; hence, its name. By this means the internal organs, which, anatomically considered, are entirely separated from each other, are bound together physiologically, so that they act in harmony one with another; thus producing that unity of action, throughout the nutritive apparatus, so necessary to the preservation of the life and health of the individual.

38. Nowhere in the human frame do we find a more perfect adaptation of means to produce certain ends, than in the intricate system of nerves pervading every part of the body. Through them we become acquainted with the world around us, and through them our own existence is made known to others. The nerve-centres in the brain are the seat of all the intellectual faculties, by which we can contemplate things earthly, and things divine; for the human mind seems to be the connecting link between the animal and the spiritual world. It can take cognizance of the life of the creature, and all its manifold relations with the things of time and sense; and it can be impressed with the truths of Deity, and be made to feel and know that they are truths divine!

QUESTIONS.

SECTION II.

1. What is said of the functions of the nervous system?
2. Over what does the cerebro-spinal system preside? The sympathetic system? What is said of their development in animals?
3. Of what is the nervous system composed?
4. What is remarked of the nerve-centres?
5. How must all communications between two organs be made? Why is this called reflex action?
6. What effects are produced by exciting the nerves?
7. In what two forms does all nerve-power show itself? What function is possessed by both sets of nerves?
8. What is remarked of nervous irritability?
9. How is the function of an organ excited into action?
10. How is the function excited by sympathy?
11. What occurs when a nerve-fibre is broken?
12. What parts of the body are supplied by the spinal cord?
13. What does the power of sensation enable us to do? Upon what does this power depend?
14. What is said of the sensation of pain? How may this sensation be blunted?
15. What is done with the impressions made through the sensitive nerves? Illustrate by examples.
16. What is said of the connection in function between the sensitive and motor nerves?
17. What is remarked of the fibres in the roots and the trunks of the spinal nerves?
18. Of what kind of fibres are the spinal columns composed? How are sensitive impressions carried to the brain? Motor impressions from the brain?
19. Where do the fibres of the anterior columns decussate? What is the result of this?
20. Where do the fibres of the posterior columns decussate?
21. May a nerve be irritated along its course? Where is the impression made?
22. What is said of the action of each nerve-fibre?
23. Describe associated sensations, and associated movements.
24. How does the irritability of sensitive nerves cease?
25. In what parts of the brain are the functions of sensation and motion?
26. Of what is the cerebrum the seat?
27. The cerebellum?
28. The medulla oblongata?

29. Define the instinctive actions of the cerebro-spinal system.

30. The reasoning actions.

31. How may the nerves from the brain be classified? Name the nerves of special sense. The motor nerves. The sensitive nerves.

32. What is said of the class of motor nerves?

33. What of the sensitive nerves? What of the functions of the cranial nerves, and the spinal nerves?

34. What is said of the action of the sympathetic nerve?

35. Explain how this slowness of movement operates on the system.

36. What are the three kinds of reflex action produced through the sympathetic system?

37. What is said of the sympathy of feeling among the internal organs?

38. What is remarked of the adaptation of means to ends?

SECTION III.

ANATOMY OF THE ORGANS OF SPECIAL SENSE.

1. **The Tongue,** which is the organ of **taste,** is composed of muscles covered by mucous membrane, and is situated within the arch of the lower jaw. It is attached by its root to the hyoid bone, and by the middle part of its under surface to the floor of the mouth, while its sides, its upper surface, and its tip are free. Upon the anterior part of the upper surface of the tongue are numerous small eminences, called the papillæ of taste.

2. **The papil'læ of taste are of three kinds;** the circumvallate, the capitate, and the conical papillæ. The **Circumval'late** papillæ number about a dozen, and are arranged in the form of a V across the tongue, about two-thirds of the way from its tip to its root. The **Cap'itate** papillæ, which are numerous, small, red eminences, and the **Con'ical papillæ,** which are still smaller and more numerous, cover the two-thirds of the surface of the tongue next its tip.

3. All the papillæ of taste, and the spaces betwe
are covered with **simple papillæ.** From the

that surround the conical papillæ, the squamous epithelium rises in hair-like appendages, which are admirably adapted to the imbibition of liquids to be tasted. These hair-like projections give the tongue a velvety appearance in health; but they usually become "coated or furred" in sickness.

4. **The nerves of the special sense of taste** are the lingual branch of the fifth pair of nerves, and the glosso-pharyngeal nerve. Filaments from each of these nerves pass into all the papillæ, and also to the mucous membrane of the tongue.

5. **The Nose** is the organ of the special sense of **smell**; yet it performs a part in the respiration and the voice. It is composed of cartilage, which is covered by muscles and skin. At its lower part are the two nostrils, or orifices, separated from each other by a partition consisting of bone and cartilage. The nostrils open externally in front, and into the pharynx behind, and are lined throughout by mucous membrane, which is continuous with that of the throat.

6. **The olfac'tory nerves,** or nerves of smell, pass through the foramina of the cribriform plate of the ethmoid bone, in the roof of the nasal cavities. They are in *two groups;* one of which is distributed to the inner wall and the other to the outer wall of the nostrils.

7. **The Eye** is the special organ of **sight,** and includes the eyeball and its appendages. **The eyebrows** are the hairy brows, or arches, situated between the upper eyelid and the forehead. **The eyelids** are two curtains, situated in front of the eyeball, and fringed at their free edges with the eyelashes. They are composed of skin externally; then the orbicular muscle, which is concerned in winking; next the palpebral cartilages and glands; and then the lining or internal membrane, called the conjunctiva.

8. **The Pal'pebral cartilages,** one in each eyelid, are thin plates of fibro-cartilage, which preserve the shape of the eyelids, and are placed next to their free margin. **The Pal'pebral glands** number about twenty to each eyelid.

They are situated between the palpebral cartilages and the conjunctiva, and are arranged vertically. They open at the margins of the eyelids, and secrete an oily fluid which prevents the tears from escaping along those margins. The edges of the eyelids are furnished with stiff hairs, called

Fig. 46.

Fig. 46. A View of the Right Eye. — 1, The lachrymal gland; 2, lachrymal canals; 3, nasal duct.

eyelashes, which curve downward from the lower lid, and upward from the upper lid.

9. **The Conjunc'tiva** is a thin, transparent, mucous membrane lining the inner surface of the eyelids, and is thence reflected over the front of the eyeball.

10. **The Lach'rymal apparatus**, which secretes the tears, consists of the lachrymal gland, lachrymal canals, and the nasal duct. **The Lach'rymal gland** is situated at the upper part of the outer angle of the orbit. It consists of two portions; the larger one being about the size and shape of an almond kernel. It is a racemose gland, with about half a dozen ducts, arranged transversely, and opening in the conjunctiva above the outer angle of the eye.

11. **The Lach'rymal canals** commence at the edge of each eyelid, near the inner angle of the eye, by a minute orifice. They open into the **Na'sal duct**, which is the passage to convey the tears from the eye to the nose. It is nearly an

inch long, and is lined with mucous membrane, which is continuous above with the mucous membrane of the eyelids, and below with that of the nose. **The tears** from the lachrymal gland enter the eye at its outer angle, then pass between the eyeball and the eyelids to the inner angle, where they enter the lachrymal canals, and are thence conveyed through the nasal duct into the nose.

12. **The Eyeball** is situated in the orbit, with the eyelids in front of it, and a cushion of fat behind it. It is spherical in shape, and is nearly an inch in diameter. The eyeball is composed of three concentric envelopes or coats, which enclose the three humors of the eye. *The three coats*, are the sclerotic coat, with the cornea in front; the choroid coat, with the iris in front; and the retina. *The three humors*, are the aqueous humor, the crystalline lens, and the vitreous humor.

13. **The muscles of the eyeball** are divided into straight muscles and oblique muscles. The **straight** muscles of the eyeball are the superior, the inferior, the external, and the internal muscle. They arise at the optic foramen, and are inserted

Fig. 47.

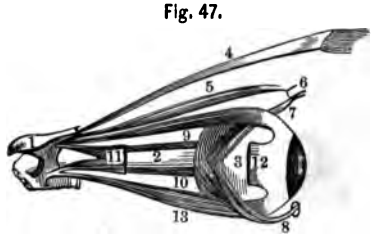


Fig. 47. THE MUSCLES OF THE EYEBALL.—1, Sphenoid bone through which the optic nerve passes; 2, optic nerve; 3, the eyeball; 4, muscle to raise the upper eyelid; 5, 7, superior oblique muscle; 6, its pulley; 8, inferior oblique muscle; 9, superior straight muscle; 10, internal straight muscle, nearly hidden by the optic nerve; 11, 12, parts of the external straight muscle; 13, inferior straight muscle.

into the sclerotic coat near the cornea. The superior muscle draws the eyeball upward, the inferior draws it downward, the external draws it outward, and the internal draws it

inward. The united action of the straight muscles draws the eyeball back into the orbit.

14. **There are two oblique muscles**; the superior and the inferior. *The superior oblique* muscle has its origin above the optic foramen, and its course along the inner side of the orbit. It ends in a tendon, which passes through a pulley, and then turns backward and outward, and is inserted between the external and the superior straight muscle. The *inferior oblique* muscle passes from the internal angle of the orbit outward and backward, and is inserted into the outer part of the eyeball. The oblique muscles protrude the eyeball, and rotate it in opposite directions.

15. **The Sclerot'ic coat** is composed of a very strong white fibrous membrane, which forms the exterior wall of the eyeball. At its back part is an orifice, through which the *optic nerve* passes. The sheath of the nerve is continuous with the sclerotic coat. At its front part is a circular aperture into which the cornea is inserted, like a watch-crystal in its frame. **The cor'nea,** which occupies about the fifth part of the wall of the eyeball, is a transparent, fibrous membrane lined in front by the conjunctiva.

16. **The Cho'roid coat** is a thin, vascular membrane situated next within the sclerotic coat. It consists of a vascular lamina, lined by a pigmentary layer, which is very smooth and very black. In **Albinoes,** this black matter is absent, and the choroid coat presents a red color from the numerous blood-vessels in it.

17. **The I'ris** is a flat disk, whose circumference is connected with the choroid coat by a whitish zone, called the ciliary muscle. The iris has a central aperture, named the **pupil,** which dilates or contracts, so as to regulate the amount of light received by the retina. In different individuals the iris presents various tints or shades of blue, gray, brown, or black. It is a fibrous structure with unstriated muscular fibres, forming a circular layer around the pupil, and regulating its size.

18. **The Ret'ina** is the inner coat of the eye. It is a soft, nearly colorless membrane, and is formed by the optic nerve, which expands and spreads over the inner surface of the

Fig. 48.

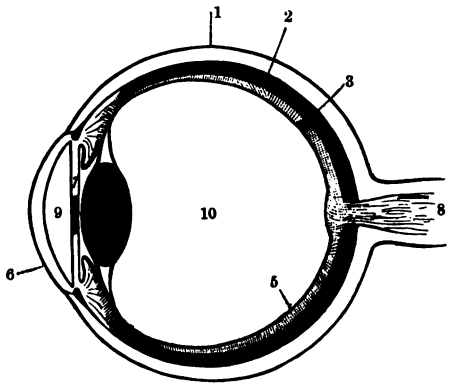


Fig. 48. SECTION OF THE EYEBALL. — 1, Sclerotic coat; 2, choroid coat; 3, retina; 4, crystalline lens; 5, hyaloid membrane; 6, cornea; 7, iris; 8, optic nerve; 9, aqueous humor; 10, vitreous humor.

choroid coat, as far front as the ciliary muscle, where it ends in a waving margin. It is the sensitive coat of the eyeball, and it receives all impressions made upon the eye by external things.

19. **The A'queous humor** is a clear, colorless, watery liquid, filling the space between the cornea and the crystalline lens. The space occupied by this humor is divided by the iris into two parts; called the anterior and the posterior chambers of the eye.

20. **The Crys'talline lens** is situated between the aqueous or in front, and the vitreous humor behind. It is a le convex lens, composed of concentric layers, like the of an onion. It is a perfectly transparent and color- stance, enclosed in a capsule, and surrounded by the ocesses.

Vit'reous humor is also clear and colorless, and the space within the retina and the ciliary

muscle. It is a viscid liquid, and is contained within a delicate structure, called the *hyaloid membrane.*

22. **The Ear** is the special organ of **hearing.** It may be divided into the external, the middle, and the internal ear, or labyrinth.

Fig. 49.

Fig. 49. A View of the Ear.—1, The external ear; 2, the external auditory canal; 3, the tympanic membrane; 4, the middle ear; 5, the Eustachian tube; 6, the internal ear; 7, the semicircular canals; 8, the cochlea; 9, a portion of bone.

23. **The External Ear** consists of the auricle and the external auditory canal. **The auricle** is composed of fibro-cartilage, closely covered by the skin, and is the part called the *ear* in common language. **The external auditory canal** is about one inch long, is narrowest in the middle, and extends from the auricle inward towards the brain. The outer portion is composed of fibro-cartilage, and the inner portion of bone; and both parts are lined with skin. The skin of the outer part is furnished with numerous short hairs, and also with glands, which secrete the *cerumen, or ear-wax.*

24. **The cavity, called the Middle Ear,** consists of the tym'panum and the Eustach'ian tube, both of which contain air. It is everywhere lined by a delicate mucous membrane, continuous with that of the pharynx, or throat.

25. **The Tym'panum,** or drum of the ear, is an irregular bony cavity between the external and the internal ear, and is separated from the external canal, by a thin, translucent membrane, called the *tympanic membrane.* Three small bones, called the **mallet,** the **anvil,** and the **stirrup,** are situated in the upper part of the tympanum, and form a chain of bones in the order named. The mallet is attached to the tympanic membrane, at one end of the chain, while the stirrup joins the oval window, communicating with the internal ear at the other end; thus, forming a continued connection by which the vibrations of the tympanum are carried to the internal ear.

26. **The Eusta'chian tube** is a canal about one and a half inches long, and extends from the fore part of the tympanum to the pharynx. Its upper portion is bony; but its lower and longer part is composed of cartilage and fibrous membrane, formed into a trumpet-shaped tube.

27. **The Internal Ear, or Lab'yrinth,** so called from its complex character, is divided into three parts; named the vestibule, the semicircular canals, and the cochlea.

28. **The Ves'tibule** is a small, oval cavity, communicating with the tympanum by the oval window, and situated between the cochlea and the semicircular canals.

29. **The Semicir'cular Canals** are three in number. They are curved so that each canal forms rather more than half a circle. Two of them open at each extremity into the vestibule, and the third conjoins with one of the other canals at one end, and opens into the vestibule at the other end; so that there are five openings from the three canals. Both the canals and the vestibule contain a serous liquid; and in this liquid floats a pouch or bag, called the membranous labyrinth, which is of the same shape as the vestibule and the canals, and is also filled with a serous liquid. A branch of the auditory nerve is distributed to this membranous labyrinth.

30. **The Coch'lea,** named from its resemblance to a snail-

shell, is situated in front of the vestibule. It consists of a bony canal wound nearly three times around a hollow axis, so as to form a spiral cone. This canal is separated by a membrane into two passages, which communicate with each other only at the apex of the cone. At the lower extremity of the cone, one of the passages opens into the tympanum, and the other into the vestibule. A branch of the auditory nerve is distributed to the cochlea.

31. **The Skin** is the natural covering of the body, and is the organ of **touch.** It varies somewhat in thickness in different parts of the body, being thinnest on the eyelids and lips, and thickest on the back, the palms of the hands, and the soles of the feet; and it serves as a protection to the muscles, the bones, the blood-vessels, and the nerves placed beneath it. The skin varies in different individuals; but it is mostly smooth, soft, and flexible in young persons; while it becomes harder and more or less wrinkled in the aged.

32. **The skin is composed of two layers,** the dermis, and the epidermis; it contains two kinds of glands, the sweat glands, and the sebaceous glands; and it is furnished with two appendages, the hairs, and the nails.

33. **The Der'mis is the deeper layer of the skin.** It is of a pinkish cream-color, and is mainly composed of a dense fibrous tissue, although it contains a few unstriated muscular fibres which contract under the influence of cold, fear, or electricity, so as to produce the phenomenon of "goose-flesh." Its outer surface is furnished with **tactile papillæ,** which vary in number and size, being most numerous and longest on the palms of the hands, and the soles of the feet. Each papilla contains the terminal filament of a sensitive nerve, and a looped capillary blood-vessel. The dermis is richly supplied with nerves, blood-vessels, and lymphatics, each of which forms a close network of vessels near its exterior surface.

34. **The Epider'mis is the external layer of the skin.** It is without nerves and blood-vessels; therefore, it is not sensi-

tive to the touch, and it will not bleed upon injury. It consists of two layers; the soft epidermic layer, and the cuticle.

35. **The Soft Epider'mic layer is next above the dermis.** It is composed of delicate polyhedral cells, formed from the dermis; and these cells are changed into dry scales to form the cuticle. The soft epidermic layer contains more or less black pigmentary matter, which gives the various shades of complexion in the skin of the different races, and in different individuals of the same race. In a very white skin, this coloring matter is almost if not entirely absent.

36. **The Cu'ticle is the external layer of the epidermis.** It is composed of scales from the soft epidermic layer; and it is constantly shedding these from its surface in the form of small flakes or scales, called scurf, or dandruff. When blisters are applied to the skin, the cuticle is the part removed. When the skin is subjected to pressure, or to friction, the cuticle becomes thickened and hardened, and then excites inflammation by pressing on the dermis beneath; thus, producing what is called a "corn."

Fig. 50.

Fig. 50. VERTICAL SECTION OF THE SKIN; HIGHLY MAGNIFIED. — 1, Epidermis; 2, cuticle; 3, soft epidermic layer; 4, dermis; 5, outer surface of the dermis, containing the tactile papillæ; 6, sweat gland; 7, sweat duct opening on the surface of the skin.

37. In nearly every part of the body, small glands, called **Sweat glands,** are found in the skin. They are so numerous that their number, in an ordinary sized man, is estimated to be about two millions. Their average diameter is about the $\frac{1}{70}$ part of an inch. Each gland consists of a tube, which is coiled into a ball, and then ascends more or less spirally to the surface of the skin. These tubes are about the $\frac{1}{400}$ of an inch in diameter, and the $\frac{1}{15}$ of an inch in length. The

entire length of all the sweat tubes in the body, is about two and a half miles. The sweat glands secrete a watery liquid, called the *sweat, or perspiration.*

38. The skin also contains another set of glands, called the **Seba'ceous glands.** They are very numerous, and they secrete an oily substance, which anoints the hair and keeps the skin soft and moist. The greasiness of the skin, from this secretion, causes the dirt to adhere readily to it, and thus to close up the mouths of the ducts, so that frequent washing with soap and water is necessary for its removal. These glands are most numerous about the roots of the hairs. When they become diseased, so that their secretion ceases, the hairs become dry and brittle, are easily split or broken, and soon cease to grow.

39. Almost all parts of the body, except the palms of the hands and the soles of the feet, are covered more or less with **hairs,** which vary much in color, in size, and in form. The portion of the hair projecting from the skin, is called its **shaft, or stem**; and the part inserted into the skin, is the **root, or bulb.**

40. **The shaft of the hair** consists of a cuticle, a cortical substance, and a medullary substance. **The cuticle of the hair** is composed of a single layer of thin, flattened cells, which overlap somewhat like the shingles of a roof, the projecting edges being turned away from the root, or bulb. **The cortical substance** forms the chief bulk of the hair; and it contains the matter which gives the hair such a variety of colors. **The medullary substance** forms the axis of the hair, although it is frequently absent.

Fig. 51.

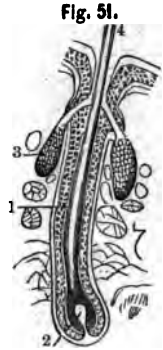


Fig. 51. THE ROOT OF A HAIR, MAGNIFIED.—1, Root of the hair; 2, the hair papilla; 3, the sebaceous glands; 4, the shaft of the hair.

41. **The root of the hair is placed in the hair follicle,** which is im-

bedded in the dermis, or the connective tissue beneath it. At the bottom of the hair follicle is a **papilla,** which contains both nerves and blood-vessels, and from which the hair grows. The root of the hair is composed of soft, polyhedral, nucleated cells, which are produced from the papilla. As these new cells are formed at the bottom of the root, they push the hair further out, and thus it grows in length. When a hair is extracted, it is reproduced by the papilla and hair follicle.

42. **The Nails,** on the fingers and toes, are horny appendages, corresponding with the claws and hoofs of other animals. They are flexible, translucent plates, continuous with the epidermis, and resting on a depressed surface of the dermis, called the matrix, or bed. The root and lateral edges of the nail are imbedded in grooves in the matrix, while the remaining part ends in a free border. The nails grow in length by the addition of cells at the root; and they grow in thickness by the addition of cells to their under surface.

QUESTIONS.

SECTION III.

1. Describe the structure and position of the tongue.
2. Describe the papillæ of taste.
3. Describe the simple papillæ.
4. Which are the nerves of taste?
5. Describe the nose.
6. Describe the nerves of smell.
7. Describe the eye.
8. Describe the palpebral cartilages and glands. The eyelashes.
9. Describe the conjunctiva.
10. Of what does the lachrymal apparatus consist? Describe the lachrymal glands.
11. Describe the lachrymal canals. The nasal ducts. Describe the course of the tears.

12. Describe the position and shape of the eyeball. What is said of its coats and its humors?
13. Describe the straight muscles of the eye.
14. The oblique muscles of the eye.
15. The sclerotic coat of the eye. The cornea.
16. The choroid coat.
17. Describe the iris.
18. The retina.
19. The aqueous humor.
20. The crystalline lens.
21. The vitreous humor.
22. Name the divisions of the ear.
23. Describe the external ear.
24. Of what does the middle ear consist?
25. Describe the tympanum. The chain of bones.
26. The eustachian tube.
27. The labyrinth.
28. The vestibule.
29. The semicircular canals.
30. The cochlea.
31. Describe the skin.
32. Of what is the skin composed?
33. Describe the dermis.
34. Describe the epidermis.
35. Describe the soft epidermic layer.
36. The cuticle.
37. Describe the sweat glands.
38. Describe the sebaceous glands.
39. With what are all parts of the body more or less covered?
40. Describe the shaft of the hair.
41. Describe the root of the hair.
42. Describe the nails.

SECTION IV.

PHYSIOLOGY OF THE ORGANS OF SPECIAL SENSE.

1. **The sense of Taste** is confined to the tongue, the soft palate, the fauces, and the pharynx; but these organs are also endowed with a *general sensibility*, similar to that of other parts of the body. Before a substance can be tasted,

it must be in a state of *solution*, so that it can come in contact with the nerves of taste; therefore, the sense of taste is not excited by insoluble substances, such as glass or sand; neither will it be perceived when the tongue is heavily coated, as in many cases of sickness.

2. The substances which excite the sense of taste comprise four classes: the sour, as tartaric acid; the sweet, as sugar; the bitter, as quinine; and the saline, as common salt. This sense seems to be limited to the posterior third of the tongue, and to its margin and tip. *The posterior part is more sensitive to salt and to bitter impressions;* and as this part of the tongue is supplied by the glosso-pharyngeal nerve, these impressions often act sympathetically on the stomach, producing nausea and vomiting; but *the margin or tip perceives more acutely sweet and sour tastes;* and as these parts are supplied by the fifth pair of nerves, which also supply the face, the countenance is often involuntarily distorted.

3. *The sense of taste appears naturally to act as a guide in the selection of food;* because articles that are palatable are generally wholesome. The taste, however, becomes perverted by the habitual use of certain articles, such as tobacco, stimulating drinks, and pungent substances generally; and a liking for almost any article may be acquired by habit, as is the case with the Esquimau who drinks whale-oil, and the Cannibal who eats human flesh.

4. **The sense of Smell is confined to the nose.** It may be excited without the substance coming in contact with the olfactory nerves; but the odor from the substance must impress those nerves. What this *odor* is we cannot tell; because articles do emit an odor, even for months and years, and yet undergo no appreciable change. Volatile substances and those in a gaseous form usually emit more odor than solids.

5. *Smell aids much in the proper choice of food,* warning us to reject such articles as have a rancid or a putrid odor, and which generally are unfit to be taken into the stomach. It

also warns us against offensive odors from gases, the most of which are unfit to be breathed; but we may become accustomed to many of these odors, so as to notice them but little; as is the case in poorly ventilated rooms where several persons are congregated.

6. *The sense of smell is very feeble in man* compared with what it is in some of the inferior animals. The lion and other carnivorous animals scent their prey from a great distance; the dog can track the fox and other animals for miles through fields and thickets; and the herbivorous animals, such as the deer and the sheep, often discover the approach of their natural enemies by the sense of smell alone.

7. **The sense of Sight, or Vision, is confined to the eye.** It is one of the most important of the special senses, and contributes in a great degree to our comfort and our happiness. By it we become acquainted with the color, the form, the size, the position, the distance, the movements, and other physical properties belonging to external objects. But we may have all these impressions from internal sources, as in dreams, which are often of such a nature as to powerfully impress us. Impressions similar to these are also produced by nervous diseases of the brain.

8. *Vision does not require contact with a substance*, neither does it require any emanation from that substance; but it needs the intervention of another agent, called *light*, by which objects become visible. The eye may receive the impressions of light from a great distance, even from the fixed stars, which are millions of miles away from the earth.

9. *All impressions from the light are made upon the retina of the eye*, which is insensible to impressions of every other kind. Its sensibility to the light is so great, that it not only appreciates the different colors of objects, but also the shading and blending of those colors, so as to readily distinguish them one from another.

10. *The retina, which is so sensitive to light, is protected by the eyelids and the iris.* When the light is greatly in excess,

the eyelids may be partially or entirely closed, thus excluding a part or all of its rays; but when the amount of light is more moderate, the iris regulates the supply by causing the pupil to contract or dilate, and thus admit fewer or more rays as occasion requires. The size of the pupil is, therefore, constantly varying, according to the intensity of the light falling upon the retina.

11. The retina is not capable of distinguishing very minute objects individually, when they are placed close together; thus, fine particles of blue and of yellow powder, when mixed together, give a green color; and black substances when mixed with white, give a gray color. If these mixtures be examined under a microscope, the color of the different grains is easily distinguished.

12. *Impressions made upon the retina by any object remain for a short time* after the object is removed; thus, when a stick, lit at one end, is moved rapidly around in a circle, the impression remains long enough to give it the appearance of an unbroken ring of fire; and when a wheel with spokes moves around rapidly, it appears to be solid.

13. *The distinctness of vision depends upon the crystalline lens* converging the rays of light to a focus, just at the surface of the retina. If the lens be too *convex*, it will bring the rays to a focus before they reach the retina, causing dimness and confusion of vision. If the lens be too *flat*, the rays will reach the retina before being collected into a focus, also causing dimness and confusion of vision. This condition of the crystalline lens is remedied by the use of *spectacles* with glasses more or less convex or concave to suit the case. The rays of light must come to a focus exactly at the retina, or the sight will not be clear.

14. *We cannot see two objects at different distances from us at the same time;* therefore, whenever the sight is directed from one object to another, a change must take place in the eye by which it is adapted to view that object; but how this change is effected has given rise to much discussion. The

usual explanation is, that the ciliary ligament and ciliary muscle change the convexity of the lens by compressing its edges, and thus adapt it to the ever varying distances of objects. The lens is made more convex for near objects, and less convex for those far away. When an object is within six inches of the eye, it is imperfectly seen; but from six inches even to millions of miles away, as in the fixed stars, the eye can perfectly adapt itself to the distance.

15. *The field of vision* is the circle within which objects may be seen without changing the position of the eyes. It is small, near the eye, but increases in size the farther it is removed from the organ of sight.

16. **The eyeball is protected by the eyelids,** which may be closed and thus keep out all foreign particles, such as dust, ashes, and sand. When any of these adhere to the conjunctiva, they are quickly removed by the eyelids, which are continually winking while we are awake. **The tears,** which are constantly secreted by the lachrymal gland, lubricate the front of the eye and keep the conjunctiva moist and transparent, so that the rays of light freely pass through it. Any irritating substances under the eyelids increase the flow of the tears; and mental emotions, whether of joy or sorrow, cause them to overflow and roll down the cheeks.

17. **The sense of Hearing is confined to the ear.** It depends upon the vibrations or waves excited in the atmosphere, called the waves of sound. These vibrations, or waves of sound, enter the external ear and strike against the tympanic membrane; they are then carried along the chain of bones to the labyrinth, and are brought in contact with the auditory nerves, where the sense of sound is produced.

18. *The sense of hearing, like that of sight, requires the intervention of a third agent,* which is usually the atmosphere; but it may be a liquid, or a solid body. A bell rung in vacuum does not produce any noise; hence, a medium of some kind is needed before a sound can be produced.

19. *The variety of sound which can be distinguished by the human ear is very great;* for it can detect various degrees in the quality, intensity, pitch, duration, and direction of sound. The ear, however, may become accustomed to sounds so as not to notice them; this is often the case with the ticking of a clock, the rumbling of a wagon, and the rattling of machinery.

20. *The five special senses are all capable of education; the touch* may be so trained that the blind can read by means of raised letters, which they feel with their fingers; *the ear* may be educated so as to distinguish various musical notes and other sounds; *the eye* may be taught the finer variations of color, size, and shape, which are not observed by ordinary vision; *the tongue* soon learns to judge of teas and wines by their taste; and *the nose* can acquire the habit of correctly judging many articles by their odor. This education, however, does not depend upon the organs of special sense, but rather upon the perceptive and discriminating faculties centred in the brain.

21. **The sense of Touch** is possessed by nearly all parts of the surface of the body; but it is more acute in the hands than elsewhere. They are provided with the papillæ of touch, which have been estimated to number not less than twenty thousand to the square inch on the palmar surface of the fingers.

22. When two needles, touching the ends of the fingers, are one-twentieth of an inch apart, two impressions are felt, but when nearer together than this, only one impression is perceived. The needles must be twice as far apart on the palm of the hand, four times as far on the lips, twenty times as far, or one inch, on the forehead, and not less than two inches on the back part of the body, in order that each needle may produce an impression.

23. *The sense of touch is the simplest of the senses;* yet it brings us into the most intimate relations with external objects, by which we learn whether they are hot or cold, hard

or soft, rough or smooth, at rest or in motion; and it aids the sense of sight by proving the reality of its perceptions by actual contact.

24. *The skin, besides being the organ of touch, serves a most useful purpose as a covering for the body.* It aids in keeping the tissues and organs in their places; it protects the delicate nerves, lymphatics, and blood-vessels found everywhere beneath it; it is so admirably arranged that delicate impressions are easily made upon the sensitive nerves in the dermis; and yet its external layer, the cuticle, is of such a structure as mostly to remain uninjured, even when brought in contact with foreign bodies.

25. **The sweat, or perspiration,** is a clear, colorless, watery liquid, secreted by the sweat glands in the skin. The perspiration is a constant secretion, but it is so gradual, when the body is in repose, that it is immediately carried off from the skin by evaporation, and is, therefore, called *insensible* perspiration. When it is increased by bodily exertion, or by an elevated temperature of the air, it collects in drops on the skin, and is then called *sensible* perspiration.

26. *One office of the perspiration seems to be to regulate the temperature of the body;* for when exercise quickens the circulation, and increases the animal heat, the perspiration is exuded in greater abundance upon the skin, where its evaporation reduces the temperature, and keeps the system from being overheated. This evaporation is one of the most fruitful sources of colds, which are almost sure to follow whenever the body is quickly reduced much below its natural temperature.

27. *A person can bear a very elevated temperature,* so long as the atmosphere is dry, and evaporation takes place freely from the surface of the body; but when the air is moist, and evaporation from the skin is retarded, the system cannot bear so high a temperature. A temperature from 400° to 600° has been borne for a time, without serious inconvenience. In these cases, the temperature of the body is but little, if any, increased.

28. *The skin exhales* both carbonic acid and animal matter from its surface, and absorbs oxygen from the atmosphere, having, in this respect, a function very similar to that of the lungs.

QUESTIONS.

SECTION IV.

1. What is said of the sense of taste? Why must the substance tasted be in a state of solution?
2. To what kind of impressions are the parts of the tongue most sensitive?
3. How does the taste act as a guide in selecting food? How may it be perverted?
4. What is necessary to excite the sense of smell?
5. How does smell aid in the choice of food? In regard to gases?
6. How is the sense of smell in man compared with other animals?
7. What is remarked of the sense of sight? From what other source may these impressions come?
8. What is needed to excite the sense of sight?
9. Where are all impressions of objects made?
10. How is the retina protected by the eyelids and the iris?
11. How do minute objects placed close together affect the retina?
12. Do impressions upon the retina remain there?
13. Upon what does the distinctness of vision depend? How can the dimness be remedied?
14. What is remarked of seeing objects at different distances? How is the lens adapted to the distance of objects?
15. What is said of the field of vision?
16. How is the eyeball protected from dust and sand? What is said of the tears?
17. Upon what does the sense of hearing depend? How do the waves of sound reach the auditory nerves?
18. What third agent is needed in the sense of hearing?
19. What is said of the variety of sound? To what may the ear become accustomed?
20. What is remarked of the education of the special senses? Upon what does this education depend?
21. What is said of the sense of touch?
22. How far apart must objects be to make distinct impressions upon different parts of the body?

23. Of what use is the sense of touch?
24. What are the functions of the skin?
25. What is remarked of the perspiration?
26. How does the perspiration regulate the temperature of the body?
27. What elevation of temperature can be borne by the human body?
28. What substances are exhaled from or absorbed by the skin?

Development of Tissues.

The starting point from which the human being is developed, is the **primitive organic cell.** This cell is more or less changed or modified in shape, so as to form the different tissues of the body. These tissues make up the liquids and the solids of the whole system. Some of the solids are composed of a single tissue, while others are formed from two or more tissues united together; but every organ in the body is composed of one or more tissues, which, in turn, are composed of organic cells. This may be understood by the following.

The Primitive Organic Cell is developed into tissues.	Tissue of cells, floating in a liquid.	Blood.	Every organ in the body is formed from one or more of these tissues.
		Lymph.	
	Tissue of cells, arranged in layers.	Epidermis.	
		Cuticle of hair.	
		Nails.	
		Epithelium.	
		Pigment.	
		Enamel.	
	Tissue of cells, collected in masses.	Adipose tissue.	
		Marrow.	
		Gray nerve tissue.	
	Tissue of cells, in the form of tubes.	Nerve fibres.	
		Muscular fibres.	
		Capillaries.	
		Lymphatics.	
		Dentine.	
	Tissue of cells, in the form of filaments.	Fibrous tissue.	
		Elastic tissue.	
	Tissue of cells, imbedded in a solid.	Cartilage.	
		Bone.	

Grouping of Organs.

The following exhibits the natural grouping of the parts or organs which compose the human body.

Bones.	Osseous System.	Motor Apparatus.	MAN.
Muscles.	Muscular System.		
Serous Membranes.	Membranous System.	Nutritive Apparatus.	
Mucous membranes.			
Salivary glands.	Glandular System.		
Gastric glands.			
Pancreas.			
Liver.			
Spleen.			
Kidneys.			
Mouth.	Digestive System.		
Palate.			
Tonsils.			
Tongue.			
Teeth.			
Pharynx.			
Œsophagus.			
Stomach.			
Intestines.			
Heart.	Circulatory System.		
Arteries.			
Capillaries.			
Veins.			
Lymphatic vessels.	Lymphatic System.		
Lymphatic glands.			
Larynx.	Respiratory System.		
Trachea.			
Lungs.			
Cerebro-spinal nerves.	Nervous System.	Sensory Apparatus.	
Sympathetic nerves.			
Tongue.	Organs of Special Sense.		
Nose.			
Eye.			
Ear.			
Skin.			

GENERAL QUESTIONS.

1. What is the starting point in the formation of a living being?
2. From what are all tissues formed?
3. Into what two classes are the tissues divided?
4. Which substances in the body are composed of cells floating in a liquid?
5. Which are composed of cells arranged in layers?
6. Which of cells in masses?
7. Which of cells in the form of tubes?
8. Which of cells in the form of filaments?
9. Which of cells in a solid substance?
10. What is the blood? What is its function?
11. What is the lymph? What is its function?
12. What is the epidermis? What is its use?
13. What part of the hair is the cuticle?
14. Where are the nails placed?
15. What is epithelium?
16. What is pigment? Where does it occur in the body?
17. What is enamel? What is its use?
18. What is adipose tissue? What is its use?
19. What is cartilage? What is its use?
20. What are nerve-fibres?
21. What are muscular fibres?
22. What are the capillaries? What is their use?
23. What are the lymphatics? Of what use are they?
24. What is fibrous tissue? Of what use is it?
25. What is elastic tissue? Of what use is it?
26. From what is every organ formed?
27. What are the bones? Where are they situated? What are their uses? Name the bones of the head. Of the trunk. Of the upper limbs. Of the lower limbs.
28. What are the muscles? Where are they situated? What are their uses? Where are the flexor muscles situated? The extensor muscles?
29. What are the serous membranes? What is their function? Where are they found?
30. What are the mucous membranes? What is their function? Where are they found?
31. Where are the salivary glands? What is their function?
32. Where are the gastric glands? What is their function?
33. Where is the pancreas? What is its function?
34. Where is the liver? What is its function?
35. Where is the spleen? What is its function?

36. Where is the mouth? What is its function?
37. Where is the palate? What is its function?
38. Where are the tonsils? What is their function?
39. Where is the tongue? What are its functions?
40. Where are the teeth? What is their function?
41. Where is the pharynx? What is its function?
42. Where is the œsophagus? What is its function?
43. Where is the stomach? What is its function?
44. Where are the small intestines? What is their function?
45. Where are the large intestines? What is their function?
46. Where is the heart? What is its function?
47. Where are the arteries? What is their function?
48. Where are the veins? What is their function?
49. Where is the larynx? What are its functions?
50. Where is the trachea? What is its function?
51. Where are the lungs? What is their function?
52. Where are the cerebro-spinal nerves? What is their function?
53. Where are the sympathetic nerves? What is their function?
54. Where is the nose? What are its functions?
55. Where is the eye? What are its functions?
56. Where is the ear? What are its functions?
57. Where is the skin? What are its functions?
58. Of what is the osseous system composed? The muscular system? The membranous system? The glandular system? The digestive system? The circulatory system? The lymphatic system? The respiratory system? The nervous system? Which are the organs of special sense?
59. Of what is the motor apparatus composed? The nutritive apparatus? The sensory apparatus?
60. Of what is Man composed?

CHAPTER V.—Hygiene.

SECTION I.

GENERAL REMARKS.

1. *Much of the sickness which afflicts the human family is without doubt produced by a neglect of the general laws of health, or Hygiene.* In very many cases these laws are imperfectly understood; hence, errors in diet, in clothing, in exercise, and in the ventilation of dwellings, are of daily occurrence, and are followed by diseases, many of which might be avoided by carefully observing the natural laws which aid in the preservation of our own existence.

2. *The object of Hygiene* is to inquire into the influence which surrounding agents, both moral and physical, have upon the human body, and to present the best means for developing the system and for preserving its functions in a state of health.

3 The human body is composed of various organs differing in structure and in function. When the function of any one organ becomes deranged, the effect is not confined to that organ alone, but it extends more or less to the whole system; thus, when digestion is impaired, the blood receives less nourishment, and all the tissues and organs of the body suffer in a corresponding degree. Moral and physical agents, therefore, act more or less upon the whole being, either directly or indirectly.

4. We have presented the whole subject of Anatomy and Physiology in the previous chapters, so that a knowledge of the structure and the function of each organ in the body, and the dependence of one organ upon another, may be fully understood. When pupils have studied these chapters, and have become acquainted with the functions of the different organs, they will be ready to take up the study of *Hygiene*, and to apply its laws to the preservation of their own existence.

5. The agents which have the most influence upon the human body, are air, water, clothing, food, sleep, and mental and physical exercise.

QUESTIONS.

SECTION I.

1. What is said of the sickness in the human family?
2. What is the object of Hygiene?
3. What is said of the dependence of one organ upon another?
4. Why has the whole subject of Anatomy and Physiology been presented? When may pupils commence the study of Hygiene?
5. What agents have the most influence on the human body?

SECTION II.

AIR.

1. *The air is composed of three gases; oxygen, nitrogen, and carbonic acid gas.* A due supply of oxygen is necessary to preserve the health; but a want of oxygen, or an increase in the amount of carbonic acid, will be injurious to the system. We have already seen that each person needs eight cubic feet of fresh air every minute, and four hundred and eighty cubic feet every hour; and this amount must be supplied, or the health will suffer.

2. *The sources of carbonic acid are from decaying animal and vegetable matter, from combustion, and from the respiration of animals.* All of these furnish carbonic acid to the air, and tend to render it unfit for breathing. Means should, therefore, be taken to counteract their injurious effects.

3. *The decay of animal and vegetable matter is more rapid in summer than in winter.* Moist air also hastens the process; for it is well known that meats, fruits, and other vegetables, spoil more quickly during the damp days of summer than at any other time. Heaps of animal or vegetable matter, and ditches of stagnant water, which always contain vegetable substances, soon become putrid during the hot weather and give off carbonic acid among their other offensive and unhealthy gases.

4. *A residence in the vicinity of slaughter-houses,* of establishments for making bone-dust, of glue manufactories, of ponds or ditches of stagnant water, of sluggish streams, or of marshy meadows, is always unhealthy. During the day the hot sun hastens the decay of the animal and vegetable matter found in such places; and during the night, and in the morning, while the dew is being dissipated, the moist air increases their exhalations and thus adds to their unhealthiness; hence, exposure to such places is more dangerous at *night* than during the day.

5. *All refuse matter, whether animal or vegetable, should be removed* from the vicinity of our dwellings; and all decayed fruit and other vegetables should be taken out of the cellars, in early spring. These underground rooms should then be well ventilated, and a coat of whitewash applied to their walls. This course will often save sickness in the family.

6. *The lights in a room help to render the air impure by consuming its oxygen and giving off carbonic acid.* A full supply of oxygen causes them to burn brightly; but as the carbonic acid increases they grow more and more dim.

7. *Carbonic acid is apt to collect in wells and other covered places.* These places should never be entered until they are

first tested by a lighted candle and found to contain air that will support life. When the candle burns brightly, the air is fit for breathing; when it burns dimly, the air is impure and unhealthy; and when it ceases to burn, the air will not support life.

8. *Carbonic acid is constantly formed in the body;* and at every expiration from the lungs it is given off to the atmosphere, which is, therefore, soon rendered unfit for breathing. Pure air must be constantly supplied; and this can only be done by a free ventilation in all the buildings occupied by human beings.

9. When badly-ventilated rooms are occupied for a time, the effect of the carbonic acid in the air may be noticed in the more hurried breathing, the increased circulation, the headache, the dulness of the intellect, and in a sensation of fulness, which causes the strong and healthy to feel oppressed, and the weak and delicate oft-times to faint.

10. When the air is not vitiated to so great an extent, it still produces depression and languor. Much of the headache, giddiness, dulness, sleepiness, yawning, and restlessness, felt by teachers and pupils in the school-room, by judges and juries in the court-room, and by all who remain long in poorly ventilated places, is due to the want of pure air.

11. *The exhalations from the body are increased by sickness,* and they sometimes emit a very unpleasant odor. This is especially the case in low forms of fever, such as typhus, typhoid, and scarlet fever, and in small-pox. Fresh air in these cases is imperatively demanded, both for the sick, and for those who are in attendance.

12. *Many of the poisonous gases have an offensive odor,* and thus our attention is directed to them. An example of this is in the gas used for illuminating cities. It is very injurious, and often fatal; but its disagreeable odor attracts attention to its presence, and enables us to make use of such means as will prevent its deleterious effects.

13. *Continued exposure to a vitiated atmosphere will always*

disturb and depress the vital powers, and will sooner or later bring on some disease to hurry its victim to an untimely grave. The respiration, the circulation, and the digestion, all become deranged when the system suffers from want of pure air; and through them the brain, the nerves, the muscles, and indeed every part of the body, cease properly to perform their functions, and disease must be the result.

14. *The continued breathing of impure air depresses the system*, giving rise to many diseases, but particularly to scrofula and consumption. This is the case, not only with man, but also with the inferior animals, which when confined in ill ventilated places, very often die of the latter disease. The best means of preventing consumption is to have an unlimited supply of pure air, to eat plenty of nutritious food, and to be well protected by clothing from the vicissitudes of the climate.

15. *Animals* are everywhere consuming the oxygen of the air and giving off carbonic acid to it; but *plants* are everywhere consuming the carbonic acid, and giving off oxygen. In this way, the proportion of these gases in the air is kept unchanged from one generation to another. How clearly may we behold in this the dependence of the animal and the vegetable kingdom upon each other! *Carbonic acid* causes the death of animals, but sustains the life of plants; while *oxygen* sustains the life of animals, but causes the death of plants.

16. *There is no agent, moral or physical, more productive of sickness and suffering to the human family, than a vitiated atmosphere;* and until this is exchanged for air that is pure and good, all other means for preserving or restoring the health, will avail but little. This fact cannot be impressed too strongly upon all, so that more attention may be given to the ventilation of all places occupied by human beings.

17. Persons accustomed to warm, unventilated rooms, where the atmosphere is vitiated, have their respiratory and other functions depressed, and, therefore, feel the less need for fresh air. Habit and the depressing influence of the foul

air dull their senses, so that they do not recognize, either by smell or by a sense of increasing infirmity, the effect of the impurities which they are breathing; hence, they are apt to continue in the practice of breathing the vitiated air until they are overtaken by some serious disease.

18. *The sleeping apartments should be well ventilated.* There is but little danger of taking cold when a person is accustomed to having his sleeping-room freely supplied with fresh air. In a room, well ventilated, the sleep is more refreshing, and the vigor and strength of the whole system is more fully restored by the night's rest. The dry mouth and throat, the headache, and the languor felt in the morning, would often be prevented by sleeping with an open door or an open window.

19. *The best means for ventilation are by properly constructed flues.* When heaters are used, and the warm air, which should always be pure, is introduced into the room by means of a pipe, there should be two flues on the side of the room opposite to where the warm air enters; one near the floor, and the other near the ceiling, so as to remove the impure air.

20. *When a stove is used for heating a room,* there should be some means provided near the ceiling for introducing fresh air into the part of the room where the stove is placed. The flues for the escape of the impure air should be opposite to the stove; thus insuring a constant circulation in the air of the apartment.

21. *As a means of ventilation, the open fireplace comes next in value to the flues.* It should always be kept open, and will be found a most excellent means for removing the impure air of a room. It is particularly valuable in a sleeping-room where there is no fire; because it does not create draughts of air to injure the sleeper. Too often, however, the fireplace is boarded up for the sake of appearance; but if its full value as a health preserver could be comprehended, it would always be left open.

22. *When a room has neither flues nor fireplace, recourse*

must be had to the doors or windows; but these should never be opened so that a draught of cold air will blow upon the inmates. The admission of fresh air through a hall or unoccupied room by means of a *door*, is better than the direct introduction of the external air through a window.

23. *The air we breathe should contain a due supply of moisture;* but when it is heated by artificial means, it is apt to become dry, and then absorbs too much of the moisture from the lungs and the skin, producing a dry and feverish condition of the system. A vessel containing water should, therefore, be kept upon the stove, or other heating apparatus, so that it may give off moisture to the heated atmosphere of the room.

24. *The air acts upon all inflamed surfaces by evaporating their moisture;* hence, they should be kept covered. Wounds, sores, burns, scalds, erysipelas, and poisons, should all be covered, so as to exclude the air. It is probable that salves, ointments, and other dressings, do much good by excluding the air, and thus keeping the parts soft and moist.

25. *The density of the air has an influence upon the respiration.* As we descend into mines in the earth, the air becomes more dense, and contains more oxygen, and the respiration is slower; but when we ascend mountains, the air becomes more rare, and contains less oxygen, and the respiration is more hurried. The human body may become accustomed to these changes of density, so as to experience but little, if any, inconvenience from them. This is the case with the inhabitants of the city of Quito, which is 9,540 feet above the level of the sea.

26. *The range of temperature within which human life can be maintained is very great;* for there is a wide difference between the burning heat of equatorial climes and the cold air of the regions of perpetual snow; yet, both are inhabited, and men frequently pass from one place to the other. Even the temperature of the air, in many parts of our own country, varies from 100° to 120° between the extremes of winter and of summer.

27. *The temperature of the air favors certain kinds of disease. In warm climates the tendency is to inflammations of the mucous membrane of the stomach and intestines*, giving rise to diarrhœa, dysentery, cholera, and diseases of the liver. Heat also acts upon the nerve centres of the brain, producing languor and listlessness, and a general disposition to avoid physical and mental labor.

28. *In cool climates the tendency is to diseases of the respiratory organs*, such as pleurisy, pneumonia, bronchitis, and consumption. Cold is a depressing agent, and it acts most injuriously upon the young, whose vigor is not fully developed; upon the old, whose powers are on the decline; and upon the invalid, whose system is enfeebled by disease.

29. *The air always contains moisture*, but the amount is continually changing. Sometimes it is so dry as to quickly evaporate all the exhalations of the body; but at other times it is so loaded with moisture, that evaporation almost ceases, and the skin is bathed in perspiration. Moist air is always depressing; but a pure, dry air, is exhilarating to the system.

30. *Sudden changes in the condition of the atmosphere* can be endured by the robust without much injury; but the young and the old, the feeble and the delicate, often suffer greatly. It is not so much the heat or the cold, the moisture or the dryness of the air, that causes disease, as it is the sudden changes, before the system can accommodate itself to them. Regulating the temperature of our houses by means of fire, and the temperature of our bodies by suitable clothing, are our best means for protection.

31. *Changes from heat to cold can be endured much better than those from cold to heat.* When any part of the body is benumbed with cold, it should not be exposed directly to the fire, or inflammation will almost surely follow. If the whole system is much depressed, the person should be taken into a cold room, and rubbed with towels so as to excite the circulation, while the temperature of the room is gradually in-

creased; but if only a part is benumbed, it should be placed in cold water, and should be gently rubbed until sensibility is restored. This is the best means for preventing *frost-bite.*

32. *A change of air from town to country often proves beneficial,* particularly during the warm weather. Even a week or two at the seaside, on the mountains, or at the quiet farm-house, will produce a buoyancy of the feelings, an augmented appetite, and an increased weight. It is the change of society, of scenery, and of the other surroundings, which acts upon the nervous system, producing the good results.

33. *Children reared in the country are generally healthier and stronger than those in large cities.* The fresh air of the country seems more invigorating than that of the city; and parents should send their children into the country, at least during the summer season, where they may enjoy such free exercise in the open air, as will tend to improve their health and develop their strength.

34. *Constant breathing is necessary for the support of human life,* and, under ordinary circumstances, the breath cannot be held for more than half a minute; but if five or six deep expirations and inspirations be taken, so as to empty the lungs as completely as possible of the impure air, and then a full inspiration be taken, from one to two minutes may elapse without breathing. This fact becomes useful when passing through places filled with smoke, or poisonous gases, and in diving into the water to save others from drowning. The pearl-divers of Ceylon are able by long practice to suspend the process of respiration for three or four minutes at a time.

QUESTIONS.

SECTION II.

1. Of what gases is the air composed? How much fresh air is needed by a person?
2. What are the sources of carbonic acid?
3. How is the decay of animal and vegetable matter hastened?
4. What places are unhealthy as a residence? Why are they more unhealthy at night?
5. What should be done with all refuse matter?
6. What effect do the lights in a room have upon the air?
7. How can the air in wells and other places be tested?
8. What becomes of the carbonic acid formed in the lungs?
9. What are the effects from breathing impure air?
10. What does air slightly vitiated produce?
11. What is said of the exhalations from the body in sickness?
12. What of the odor of poisonous gases?
13. How are the vital powers affected by a vitiated atmosphere?
14. What diseases are produced by breathing impure air? What are the best preventives of consumption?
15. What keeps the proportion of oxygen and carbonic acid in the air unchanged?
16. What agent probably produces the most sickness and suffering to the human family?
17. Why do we not recognize the impurity of the air while breathing it?
18. What is said of ventilating sleeping-rooms?
19. What are the best means for ventilation? How can a room be ventilated when heaters are used?
20. What is the best arrangement for the flues when a stove is used?
21. What is remarked of the fire-place as a ventilator?
22. What of the doors and windows as ventilators?
23. Why should the air contain moisture? How may moisture be supplied to the air in a room?
24. How does air act on inflamed parts of the body?
25. How does the density and rarity of air affect the respiration?
26. What is said of the range of temperature within which human life can be maintained?
27. What diseases are produced by warm climates?
28. What diseases by cold climates?
29. What is said of dry and of moist air?
30. How are human beings affected by sudden changes in the weather?
31. What is the best treatment for persons benumbed with cold?
32. How does a change of air from town to country prove beneficial?
33. Why should children spend the summer in the country?
34. What is remarked of suspending the process of breathing?

SECTION III.

WATER.

1. *Water forms nearly three-fourths of the weight of the body,* and is the solvent for all substances before they can enter the circulation. All articles used as food, contain water; but the system does not obtain enough from this source, and, therefore, requires a further supply in the form of drink. The average amount of water, needed by an adult man, is a little more than *four pounds* in a day.

2. Death soon occurs when a person is deprived of either food or drink. In the cases recorded, a few persons have lived *twenty days on water only;* but *seven days* is the longest period when *deprived of both food and drink.*

3. *In sickness, water should always be given in moderate quantity to the patient,* so as to prevent suffering from thirst. To the dry lips, the feverish mouth, and the parched tongue, it is often most grateful, and it helps to allay the nervous excitement so common in all fevers. Little children, too young to make their wants known, often suffer very much for want of a drink of water.

4. *Water is seldom found pure in nature;* for it mostly contains more or less foreign matter in solution. These matters so change the character of the water, that they give rise to the two varieties, known as soft water and hard water.

5. *Rain water, where it falls in the open country, is a good example of soft water,* and is the purest water found in nature. It is not entirely free from foreign substances; for it collects organic matter, dust, and other impurities from the atmosphere. While falling, the rain-water absorbs a portion of air, which it retains while flowing through the earth. It is this that imparts to spring water its agreeable taste. Soft water is always to be preferred to hard water, for cooking as well as for drinking purposes.

6. Rain water penetrates the earth, and there meets with

many substances which it dissolves. The most common of these are the carbonate and the sulphate of lime. Owing to the presence of these mineral substances, the water is called *hard water*, and is more or less unwholesome.

7. *Pure water is very essential for drinking and for cooking purposes*, and every means should be taken to have it as pure as possible. People in the country usually obtain good water, at all times, from the springs and wells dug in the earth; but people in cities are generally supplied with water from the rivers or lakes in their vicinity.

8. During the summer months the water from the lakes and rivers contains more or less organic matter, and *should be filtered before being used.* This may readily be done by letting the water pass through a barrel, filled with sand or gravel, or with coarsely powdered charcoal. Rain or snow water, when kept for drinking purposes, should be filtered in the same way, during the warm weather. The addition of ice renders the water more palatable, and is not injurious, when used in moderate quantities.

9. *The use of water free from organic impurities, for the purposes of drinking and cooking, is as essential to good health as pure air.* Whenever any doubt exists as to the character of the drinking-water, it should be carefully filtered. Impure water, by slowly introducing organic matter into the system, may poison the blood and lower the standard of health, so that the body is more subject to the influence of disease. These impurities are sometimes increased in amount, until the water becomes a poisonous instead of a healthful drink.

10. *Water is very useful as a means for cleansing the body.* It is important that the skin should be kept free from accumulations of grease and dirt, so that the perspiration may freely escape through the open pores; for "he who keeps the skin clean and soft, shuts many gates against disease." Frequent ablutions with soap and water are necessary to preserve the skin in a healthy state; and when these are neglected,

painful diseases of the skin, or of the internal organs, are apt to follow.

11. *The vigor of the system may be promoted by a judicious course of bathing;* and it, consequently, becomes an important means of strengthening the feeble powers of the invalid. When the bath is used for the purpose of strengthening the body, it should be taken once every day; but when it is simply to cleanse the skin, one or two baths a week will be sufficient.

12. *The bath should never be entered while the body is in a state of perspiration.* The contact of the water prevents the escape of the animal heat from the body, and its accumulation gives rise to internal inflammations, often of the most serious kinds. So great is this shock to the system, that it sometimes produces death in a few hours.

13. *The temperature of the bath demands our careful consideration;* for bathing will prove injurious when the amount of heat is not suited to the requirements of the system. The body receives a greater or less shock upon entering a bath; but reaction should soon follow. When this is not the case, the body should be rubbed with coarse towels until a "glow" is produced. Unless the shock is followed by reaction, the bath cannot be beneficial.

14. *The best time for bathing is in the morning before breakfast;* in the forenoon, from one to three hours before dinner; or in the evening, before retiring to sleep. A bath will probably be most beneficial when taken in the fore part of the day; yet any time will answer except the three hours after a meal, while digestion is taking place. When taken immediately after eating, the shock is apt to derange the digestive organs, and should, therefore, be avoided.

15. *The length of time for remaining in a bath must be determined by circumstances.* Much will depend upon the kind of reaction which follows. When this is vigorous, a half an hour will not be too long a time, and when very agreeable to our feelings, it may even be prolonged for an hour; but when the reaction is feeble, ten or fifteen minutes

should be the full extent of time. When the water is cold, five or ten minutes will be long enough.

16. *The cold bath should range in temperature from* 50° *to* 75° *Fahrenheit.* It is better adapted to the robust and strong, than to the delicate and weak. The direct effect of a cold bath is to depress, and when the system is already in a feeble state, it may be depressed so that reaction will fail to take place. The coldness of the bath must, therefore, depend upon the amount of vigor in the system, and should not be used when the body is suffering from fatigue. Unless the system promptly reacts, and a glow of warmth is felt soon after taking the bath, we may rest assured that its continued use will prove injurious.

17. *The tepid bath should range in temperature from* 75° *to* 90°. When the cold bath is too depressing, that is, when reaction and a glow of warmth in the body is too long in returning, then the tepid bath is to be preferred. It is less depressing in its effects, and the nervous system receives less shock from its use; it should, therefore, be used by those who are delicate; and if regularly employed day by day, and followed by a vigorous reaction, it will tend to invigorate and strengthen the system.

18. *The warm bath should range in temperature from* 90° *to* 96°. This bath is grateful to persons with a languid circulation, and in whom the powers of life are depressed. It is the bath most commonly used for removing the accumulations of dirt and other substances from the surface of the body. It calms nervous excitement, and disposes to sleep; hence, when one is tired, and excited from a journey, from overwork, or from an enfeebled constitution, the warm bath, at a temperature of about 90°, is well suited to calm the excitement, and induce refreshing sleep. It may be used by the young, the middle-aged, and by those advanced in life; and when it is regularly continued, it will help to strengthen and invigorate the system. *The hot bath* is stimulating, and should never be used unless advised by a physician.

19. *Sea-bathing* seems to be more invigorating than bathing in fresh water; but this is probably due in a great measure to the cheerful company, the swelling surf, and the exhilarating scenes always attending a plunge into the ocean at any of our sea-side resorts. A salt bath is less depressing to the system, and a person is less liable to take cold from a bath in salt water than from one in fresh water.

QUESTIONS.

SECTION III.

1. What is said of the amount and use of water in the body?
2. How long have persons lived without food and water?
3. Why should water be given to the sick?
4. What is said of the purity of water in nature?
5. What is remarked of rain, or soft water?
6. What is the cause of hard water?
7. How is pure water obtained in the country and in cities?
8. What should be done with the river and the rain water in the summer season?
9. What should be done with all impure water? How does it affect the system?
10. What is remarked in regard to keeping the skin clean?
11. What good results come from bathing? How often should baths be taken?
12. Why not enter a bath when in a state of perspiration?
13. What is remarked of the temperature of the water used for bathing?
14. What of the best time for bathing?
15. What of the length of time for remaining in the bath?
16. What is remarked of the use of the cold bath?
17. What of the use of the tepid bath?
18. What of the use of the warm bath?
19. What is said of sea-bathing?

SECTION IV.

CLOTHING.

1. *All bodies without life are constantly losing or gaining heat*, so that they are kept at the same temperature as the surrounding atmosphere. Living plants and animals also receive and give off heat; but they have a means of generating heat within themselves, thus resisting the effects of the temperature of the external air. In plants, this power is very feeble; but in animals, it is more strongly marked.

2. *The temperature of animals is usually higher than that of the air or water in which they live;* hence, heat is continually given off from their bodies to the surrounding air or water. The lower orders among animals are provided with a natural covering of hair, of fur, or of feathers, by which the animal heat of their bodies is prevented from escaping too rapidly; but man is compelled to resort to clothing of some kind for this purpose.

3. *The temperature of the human body is from* 98° *to* 100°; while the temperature of the climate in this country varies from that of the blood to 20° below zero, making a range of 120°. During the cold weather the body must be well protected by clothing so as to be kept at a uniform temperature. When the heat of the body is reduced to 80°, the individual perishes from the depressing effects of the cold; and when reduced to any point between 98° and 80°, the system receives more or less injury, corresponding with the reduction of the temperature.

4. When, from any cause, the temperature of the body is elevated to 110°, the individual perishes. In cases of *sunstroke* the body becomes overheated, and its temperature is raised often to 110° or 112°. The best preventive of sunstroke is frequently to bathe the head and face with cold water, and to wear a wet sponge or towel in the crown of the hat.

5. *The power of generating heat and of resisting the depressing effects of cold, is less in young children and in the aged, than it is in the middle period of life.* Hence, the greater necessity for the protection of the young and the old, by means of clothing and of artificial warmth. The feeble and the sick, whose powers of life are depressed below the healthful standard, cannot well bear the cold, and they should shelter themselves near the fire as well as wear warm clothing during the winter season. Cold is the chief cause of mortality among the young, the feeble, and the aged; and it is to them the great enemy of life.

6. *Sleep lowers the temperature of the body from one to two degrees;* and all the functions, even those of the circulation and respiration, are at the same time reduced in activity; consequently, more covering is necessary during sleep, than when awake. The system seems to be most depressed during the latter part of the night; for it is between midnight and sunrise that the body has the most difficulty in resisting the effects of severe cold. We are all made aware of this fact by the necessity which we find for more covering towards morning.

7. *Exercise not only increases the feeling of warmth in the body, but it actually raises its temperature.* The deeper parts of the body become only one or two degrees warmer; but the face, the hands, and the feet, may be raised many degrees. A much larger amount of animal heat is generated, when the body is exercised, than when it is in a state of repose. This extra heat causes the skin to be covered with perspiration, which evaporates, and carries the heat of the body off with it; thus preserving a nearly uniform temperature.

8. *The radiation of heat from the body, and the evaporation of the perspiration on its surface, must be regulated by the clothing,* which, therefore, requires constant attention to suit the vicissitudes of a climate so varied and changeful as this. In no other way can the body be so well guarded against colds, as by a proper amount of clothing; the object being the prevention, rather than the cure of disease.

9. *The principal object of clothing is to protect the body from heat and cold;* therefore, we must select such fabrics for wearing apparel as will best accomplish this purpose. During warm weather, the clothing should be light, so that the heat of the body may readily escape; but in cold, moist weather, the clothing should be heavier, and of such a kind as to retain the heat of the body, and at the same time to permit the exhalations to pass off freely from the skin.

10. *Clothing is made of hair, wool, silk, linen, or cotton.* Furs and woollen materials furnish the warmest kind of clothing for the body; while fabrics, made of cotton or linen, are much cooler.

11. *Linen* imbibes moisture from the body quickly, and in that way conveys the heat away very rapidly. It is well suited to a warm climate, where there are but few atmospheric changes; yet it should not be worn next to the skin, as it cools the surface too quickly, and is, therefore, a poor protection against sudden chills. *Cotton* absorbs moisture less rapidly, and is, therefore, a warmer covering for the body than linen. It is better suited for clothing, because it affords more protection against sudden changes.

12. *Woollen goods* are slow to absorb moisture; and, as they contain considerable air among their particles, they are poor conductors, and retain much of the heat of the body. Woollen goods are often spoken of as being warm; but their warmth consists in preventing the escape of the heat from the body, and the entrance of the cold to the body. They are poor conductors of both heat and cold; and they furnish the best means for protecting our bodies against the changes so frequent in our climate.

13. *Woollen flannel,* in the shape of waistcoat and drawers, should be worn next to the skin, at all times, except during the warmest weather of summer; and even then, the flannel should only be exchanged for similar articles of clothing, made of cotton. The advantage derived from wearing flannel is, that it prevents the surface of the body from being

suddenly cooled, and thus lessens the liability to colds, and to other affections of the lungs. When flannel is too irritating to the skin, it may be lined with muslin.

14. *Very young children should wear flannel next to the skin, at all seasons of the year.* It should not be taken off during the midsummer months, as it will even then afford protection from colds, and other diseases, generated by the chilly mornings and evenings.

15. *The aged and the infirm are particularly benefited by the use of flannel.* And those who suffer from rheumatic affections, who are scrofulous, or who are in any way predisposed to a weak breast, or to diseases of the chest, should be clothed in flannel from head to foot. It is the best means for preserving an equable heat in the body; and it protects against cold, as well as promotes the general comfort.

16. *The warmth of clothing depends upon its color, and its texture, as well as upon the material of which it is made.* Clothing of a black color is warmer than that which is white; hence, dark clothes are usually selected for winter, and light clothes for summer wear. Coarse fabrics, with a long nap, are much warmer than those of a finer and closer texture; and garments fitting moderately close, are warmer than those which are very large and loose.

17. *The flannel underclothing should be frequently changed.* Once or twice a week will suffice under ordinary circumstances, during the winter; but, when the body perspires freely, they need changing more frequently. All clothing worn during the day, particularly in the summer season, should be removed before retiring to rest; and, during the night, it should be well aired in a dry room.

18. *The feet should be kept warm and dry at all times.* Exposure of the feet to wet and cold is one of the most common causes of disease; hence, all persons, and particularly those who are predisposed to affections of the lungs, or to rheumatism, should be careful to keep the feet well protected by cotton or woollen stockings, and by warm boots or shoes.

When garters are worn, they should be elastic, and not too tight, or they will compress the veins of the skin and prevent the flow of blood toward the heart, often giving rise to a painful enlargement of the veins.

19. *The manner of dressing is as important as the materials used.* All garments should be as light as is consistent with the warmth and comfort of the wearer. Two or three thicknesses of flannel will often be warmer than double that weight made into a single garment, and should, therefore, be preferred.

20. *Tight-fitting garments are injurious in many ways.* They are not so warm as those moderately loose; because they prevent the free circulation of the blood. They restrict the natural motions and the healthy exercise of the body, and thus check the amount of heat; and they prevent the free movement of the muscles, and, in this way, cause *deformities* that are apt to remain until the end of life.

21. *Tight clothing obstructs the circulation of the blood, and is often the cause of serious diseases.* When the clothing presses tightly against the neck, it prevents the return of venous blood from the head, and sometimes produces congestion of the brain, and even apoplexy. The small neck-ties, now in use, are a very great improvement over the old-fashioned stocks in vogue a few years since.

22. *Tight lacing about the chest is productive of much mischief.* It cramps the action of the muscles, prevents the expansion of the lungs, compresses the heart and large blood-vessels, contracts the cavity of the chest, and generates a multitude of diseases. All clothing should be so loosely worn as to allow the lungs full opportunity for expansion, so that neither the respiration nor the circulation will be impeded.

23. *When the chest is compressed, it induces diseases of the most serious character.* A full and free expansion of the lungs is necessary for maintaining the health; and when this is prevented by tight clothing, the amount of air inspired is too small for the wants of the system, so that the venous

blood is imperfectly changed into arterial blood. The air then brings too little oxygen to the blood and carries away too little carbonic acid; hence, the body suffers from the

Fig. 52. Fig. 53.

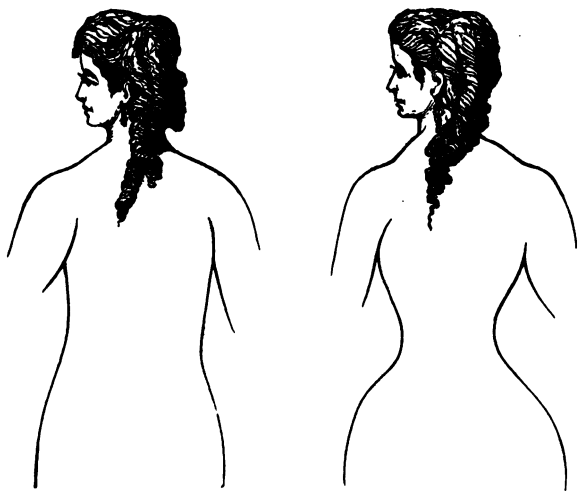


Fig. 52. The Shape of a Waist not deformed by tight-lacing.
Fig. 53. The Shape of a Waist deformed by tight-lacing.

want of fresh air, the same as it does when confined in an ill ventilated dwelling; and it becomes subject to all the evils induced by a vitiated atmosphere.

24. In children, while the bones are soft and yielding, tight lacing not only produces all these evils, but it forces the chest out of its natural shape, and prevents its natural growth. When this is the case, the organs within the chest cannot be developed; and the lungs, the heart, and the blood-vessels, never attain their full size. Good health never can be enjoyed by those who persist in the practice of tight lacing, or in any other way of constricting the free movements of the chest.

25. *When the foot receives the weight of the body, as it does in walking, it spreads out a little at the sides, and becomes somewhat longer.* The boot or the shoe should always be large enough to permit these movements. It is the lengthening of the foot that makes it so painful to walk when the boots or shoes are too short. When they are too narrow, they compress the toes and the joints, producing corns, bunions, and the ingrowing of the nails. *Gum overshoes* should be worn in wet weather, but they should always be removed while in the house; because they prevent the exhalations of the feet from being evaporated. Boots and shoes should be made heavy enough to support and protect the feet; and fashion should, in this respect, yield to health and comfort.

26. *When clothes become wet, either from the perspiration of the body, or from other causes, they should be exchanged for dry woollen garments.* The woollen clothes check the rapid evaporation, and thus prevent the body from being cooled below its natural temperature, so that neither colds, nor rheumatism, are apt to result. But when dry clothing cannot be had, the person should remain near the fire until the clothing is entirely dry; or he should continue to exercise the body, so that it will not become chilled while the clothes are wet.

27. *The amount of clothing worn must, in all cases, be according to the weather;* but the young, the feeble, and the aged, need more clothing than those who are in the full vigor of life. For persons who are advanced in years to refuse an extra garment for fear of seeming to be old, is an act of folly; and for the young to be unprovided with sufficient clothing, is often simply to lay the foundation of permanent and fatal diseases.

28. *Persons are more liable to take cold during the after part of the day, than in the morning;* because the atmosphere is then more cool and damp, and the energy of the system is more exhausted. The custom of putting on light and thin

clothing, for an afternoon and evening, has often laid the foundation of serious diseases. Instead of thinner clothing, an extra garment towards evening would be more likely to promote both health and comfort.

29. *When heated, we should never stand nor sit in a draught of wind from the door or window,* as this is one of the most fruitful sources of colds. When thus heated, instead of throwing off a part of our clothing in order to get cool, we should put on an additional garment, so as to protect the body from being cooled too rapidly. When this is done, a cold will seldom result.

30. *When clean clothing is to be put on, we should be careful to have it dry, and well aired.* Many a person has contracted a severe cold from putting on clean clothing that was not entirely dry. It would be better to expose all articles of clothing to the fire for a few minutes before they are needed.

31. *The different parts of the body should be clothed according to their requirements.* The face is usually left exposed at all seasons; but the ears and the hands are covered when it is cold. The head contains a large proportion of blood, and needs only a light covering. The neck and throat are easily overheated, and the covering for them should be light. Muffling the neck and throat of children with furs, or with woollen fabrics, is the common cause of sore throats, coughs, and croups. These parts become overheated when thus wrapped up; and when the covering is removed, and the neck left bare, as is usually the case upon entering a house, they are chilled so rapidly that sickness results.

32. *The upper and the lower limbs often go unprovided with proper clothing.* During the winter season they should never be exposed without covering; and when the child passes into the open air, both the upper and the lower limbs should be well protected with woollen garments.

33. *It is entirely wrong to suppose that children can be hardened by exposure.* Attempts of this kind too often end in disease or death. A strong child may bear up against

them; but the weak and the delicate will surely die. Clothing, food, bathing, and fresh air, are needed to promote the health and growth of children; and these must be supplied in sufficient amount, and according to sound judgment. Fashion and folly in dress should give way to those things which will produce health and happiness.

QUESTIONS.

SECTION IV.

1. How are bodies without life affected by heat? How are living bodies affected?
2. How does the temperature of animals correspond with that of the air? How are animals protected from the cold?
3. What is remarked of the temperature of the body and of the climate? How much may the human body be depressed in temperature?
4. How much may it be elevated? What is said of sunstroke?
5. How does cold affect the young and the aged? How does it affect the feeble and the sick?
6. How does sleep affect the temperature of the body?
7. How does exercise affect the temperature of the body?
8. How can the heat of the body be regulated?
9. What is the object of clothing? When should light and when should heavy clothing be used?
10. Of what materials is clothing made?
11. What is said of linen as an article of clothing? What of cotton?
12. What of woollen goods?
13. What is remarked of wearing flannel?
14. Why should children wear flannel?
15. What other classes should wear flannel?
16. Upon what does the warmth of clothing depend?
17. What is remarked of changing the underclothes? What of the clothing worn during the day?
18. What is remarked of the use of stockings?
19. What of the manner of dressing?
20. How are tight-fitting garments injurious?
21. What is the effect of tight clothing about the neck?
22. What of tight lacing about the chest?
23. Why is a free expansion of the lungs necessary?
24. How does tight lacing affect the young? The adult?

25. How are the feet affected by pressure? By gum shoes?
26. What should be done with wet garments?
27. What is said of the amount of clothing needed?
28. What is remarked of dress in the after part of the day?
29. When overheated, how can we prevent taking cold?
30. What care is needed in regard to clean clothing?
31. What is remarked of clothing the different parts of the body? The neck and throat?
32. The upper and lower limbs?
33. What is said of hardening children by exposure?

SECTION V.

FOOD.

1. The food of living creatures varies considerably. Some of them feed entirely upon vegetables, and are called *herbivorous;* some feed upon animals, and are called *carnivorous;* and others live upon a mixed food consisting of vegetables and animals, and are called *omnivorous.*

2. *Man may live upon vegetables* exclusively, as is frequently the case in tropical climates where animal food is not so easily procured, and where it is but little relished by the system; or *he may live upon animal food* alone, as is done in the frigid zones where vegetables can scarcely be obtained. It is only in temperate climates that man feeds regularly upon both animal and vegetable food.

3. *Much care in the selection of food is necessary, whether it be from the animal or the vegetable kingdom;* for each contains substances destructive to human life. Even food that is eminently wholesome at one season of the year, is unfit to be eaten at another season; and while one part of a plant may be eaten with impunity, another part of the same plant must be rejected, because it is injurious.

4. *The albuminoid substances* constitute a large part of the human body, and must, therefore, be furnished by a large

part of the food. They are found in meats, fish, eggs, milk, flour, and in vegetables generally.

5. *The fats, or oils,* are furnished by animals and vegetables. They contain a large amount of carbon, and tend to increase the heat of the body. On this account they are largely consumed by persons living in cold climates, and to a great extent enable them to resist the depressing effects of the cold.

6. *The sugars are mostly of vegetable origin,* and their sweet taste makes them favorite articles of food with all nations. The sweet taste of fruits is from the grape-sugar they contain. The sugar consumed in this country is mostly obtained from the sugar-cane; but large quantities are obtained from the sugar-maple trees. More than one million tons of sugar are annually consumed by the human family.

7. *A mixed diet is the one best suited to man.* All experiments tend to prove that when omnivorous animals are confined to a single article of food, they do not long remain in a healthy condition. When the system is long deprived of any one of the three classes of food, disease is apt to be generated; consequently, a diet which contains sugar, fat, and the albuminoid substances, in due proportion, is the healthiest, and the best.

8. *Meats contain a large amount of nourishment,* and are the most nutritious articles of food. They vary much in quality, in different animals; and much depends upon the age, the sex, and the condition of the animal when killed, as well as upon the kind of food on which it was fed. Cattle fattened upon grass or grain furnish the finest beef, and corn-fed hogs, the best pork.

9. *The flesh of young animals contains more water than the flesh of old ones;* consequently, it is more tender and juicy, but not so nutritious. The meat of young animals is generally paler and softer, and is more readily digested, than that of older animals; except that veal is less digestible than beef.

10. *All kinds of fresh meat are better during the cold weather*, and some kinds are unfit for use at any other season. Fresh pork should not be eaten in warm weather; and oysters and clams are a fruitful source of disease during the summer months.

11. *Many kinds of fish are used for food.* Their flesh is very similar to the meat of animals, although it is not so easily digested. Fish undergo decomposition rapidly, and, when tainted, are very injurious, and even poisonous to the system. They are never improved by keeping, and should be eaten as soon after being caught as possible. Winter and spring are the best seasons for fish, as the cold water seems to improve their flesh.

12. *Beef, pork, and fish, are preserved by salt*, so that they may be kept for summer use. Salt renders them less nutritious, and less digestible, by absorbing their juices, and hardening their fibres; yet, a due proportion of salt-meat agrees well with the system in warm weather.

13. *Milk* is very nutritious, is easily digested, and is well adapted as nourishment for the sick and the convalescent. *Eggs* are about one-third pure albumen and fat, and are most wholesome when soft-boiled. When fried in the fat of ham, they are very indigestible, and seldom agree with persons having dyspepsia.

14. *Vegetables enter largely into the food of man;* but they are not so easily digested as the flesh of animals. The vegetables most used for food, are included in the fruits, the garden vegetables, and the grains from which bread is made; and those taken as drink along with the food, are coffee, tea, and cocoa.

15. Among the grains used for making bread, wheat is the most valuable. *Bread* made from the flour of wheat is the main article of daily food in most households, and is often called "the staff of life." In grinding the wheat, the bran, or husk of the grain, is separated from the flour by a process called "bolting." This makes the flour whiter, but rather less digestible.

16. *Bread should not be eaten when warm*, because it forms a heavy mass in the stomach, and is not well masticated before being swallowed. *Rye bread* is less nutritious and less digestible than wheat bread, and sooner becomes sour.

17. *Indian corn* contains more fat than any of the other grains. In preparing it for food, long cooking is necessary; then it becomes an excellent article of diet. *Rice* is very digestible, and is particularly adapted to those whose powers of digestion are weak, as in cases of convalescence.

18. *Potatoes are much used for food.* They contain but little fat, and are usually associated with meat; — the three articles, bread, meat, and potatoes, forming an excellent diet, upon which human beings may subsist for a long time. In the spring, when the potatoes "sprout," they are unfit for food. They are best cooked by roasting or boiling, and should then be dry and mealy.

19. *Fruits* are prized more for their delicious taste than for their nourishing properties. When entirely ripe, they are moderately digestible, and are well suited for food. They may be cooked in many ways, and then afford excellent substitutes for other kinds of food. Unripe fruits contain starch, which renders them indigestible; but the sun converts the starch into sugar during the process of ripening.

20. Some substances give relish to other kinds of food. Among these are salt, pepper, mustard, and horse-radish. *Salt* is needed by the system, and should be taken in moderate quantities. *Pepper* is a powerful stimulant of the digestive organs, and should be used sparingly. *Mustard* is a gentle stimulant in small quantities. *Horse-radish* is an excellent relish during the winter and spring.

21. *Coffee and tea when moderately used are beneficial*, particularly to adults. They are gentle stimulants to most persons, and, in this way, assist in the digestion of other food. One half pint of this beverage at a meal is as much as should be taken. Most people prefer coffee in the morning, and tea in the evening, the latter having a tendency to induce sleep. A cup of coffee seems to strengthen the mind,

and the better to fit it for mental labor; hence, it is highly esteemed by most persons engaged in literary pursuits. *Cocoa and chocolate* are nutritious; but they are less easily digested than either coffee or tea.

22. *Alcoholic drinks should never be used unless prescribed by a physician.* They are seldom needed when in a state of health, and frequently do much harm; and they should not be resorted to in cases of sickness unless directed by the medical attendant. The action of alcohol is at first to stimulate, and in this way it gives relief to some conditions of the system; but its habitual use invariably leads to the destruction both of body and mind.

23. *The preparation of food by cooking is the common custom among nations.* The object is to render it more digestible; to develop its flavor; and to increase its temperature so as to be more agreeable to the palate. Nearly all kinds of food are cooked before they are eaten; but there are some exceptions, such as raw oysters, raw beef, and a few vegetables.

24. *The best modes of cooking meats are by roasting and broiling;* and the poorest modes are by boiling and frying. In roasting and in broiling meats the juices are preserved, and the meats are rendered more digestible than by any other way of cooking. In boiling meat a portion of the nutrient juices pass into the water and is wasted. Frying is the worst way of cooking, as the heated fat penetrates the meat, rendering it dry and hard, and making it very indigestible.

25. *Ham, sausages, and other forms of pork, should never be eaten without cooking.* The flesh of the hog often contains a slender worm, called *trichina spiralis;* which, when taken alive into the human stomach, multiplies rapidly and gives rise to a very painful and often fatal disease. When the pork is thoroughly cooked, this worm is destroyed, and the meat may then be eaten with impunity.

26. *The quantity of food required, varies greatly according to the person and his habits of life.* A person engaged in fatiguing physical labor requires more nutritious food, and larger quantities of it, than one who leads a sedentary life. The young,

who are mostly active, can digest more food than the old and feeble. The robust are able to digest food entirely unfit for the weak and the delicate; and the inhabitants of cold climates need more food than those who reside where it is warm.

27. *Dyspeptic persons, and those of feeble digestive powers, should eat such food only as is easy of digestion, and this should be small in amount.* All kinds of food should be taken in moderate quantities, so that the stomach may not be overloaded. Even digestible food becomes indigestible, when unduly forced upon the stomach. Habit often induces us to eat too much, but seldom too little. When any article of food is found to disagree with the stomach, it should be avoided.

28. *When food is not obtained in sufficient amount, the vital powers are lowered and the functions depressed.* The mind loses its vigor, the muscles their energy, the stomach its powers of digestion, and the blood its richness; and the vitality of the system is lowered, so that it becomes peculiarly liable to low forms of fever, or to other wasting diseases. In childhood, the want of proper food not only depresses the system, but also prevents its development and growth, and leads to serious diseases which seldom fail to hurry the victim to an early grave.

29. *The food taken by children serves the double purpose of repairing the waste of the body and providing for its development.* This requires a nutritious and easily digested diet. Milk, and fat and lean meat, should always compose a part of the diet. Pastry, unripe fruit, salted provisions, and acid drinks, should generally be avoided. Children may be permitted to eat more frequently than adults do; yet they should be restrained from eating too much at one time.

30. *Regularity in eating should be observed.* Three meals a day, and these from five to six hours apart, will be most conducive to health. The last one, or evening repast, should be the lightest, and should be taken three or four hours before retiring to sleep. A hearty supper should be avoided because it disturbs the sleep and produces restlessness and dreams.

31. *Eating too rapidly, without fully masticating the food, is productive of much injury.* When the food is swallowed in large lumps, the time required for its digestion is much prolonged; but when it is finely triturated by the teeth, the digestion goes on more rapidly; because the gastric juice can at once act on all parts of the food. A confirmed habit of eating rapidly is one of the most fruitful causes of dyspepsia.

32. *A hearty meal should not be taken immediately before or after severe mental or physical labor.* Severe exercise of body or mind tends to draw the blood away from the stomach, and thus lessen its functional powers. After severe labor, from thirty to sixty minutes should be allowed for rest, before eating; and after a meal, from one to two hours should elapse before proceeding to hard work, so that the stomach may properly perform its work.

33. *The state of the mind has much influence on the process of digestion.* Sudden news, whether joyful or sad, is apt to destroy the appetite, by exciting the mind so that the wants of the stomach are not noticed. Light conversation about pleasant things, and a cheerful state of mind, sharpen the appetite and promote the powers of digestion, and should therefore be encouraged while eating.

34. *Pure air increases the appetite by invigorating the whole system.* It purifies the blood and thus stimulates the function of every organ. Children, after being confined all day in a poorly ventilated school-room, and persons after sleeping in rooms not well ventilated, have little or no appetite.

QUESTIONS.

SECTION V.

1. How may animals be classified by their food?
2. What is remarked of the food of man?
3. Why is care so necessary in selecting food?
4. What are the three classes of food? What is said of the albuminoids?

5. What of the fats?
6. What of the sugars?
7. What is said of a mixed diet?
8. Upon what does the nourishment in meats depend?
9. What is remarked of the flesh of young animals?
10. How are fresh meats affected by the season?
11. What is said of fish as an article of food?
12. What is said of salting meat and fish?
13. What is said of milk for food? What of eggs?
14. What is said of vegetables for food and drink?
15. What is remarked of wheat bread?
16. Why is warm bread unwholesome? What is said of rye bread?
17. What is said of indian corn? What of rice?
18. What of potatoes as food?
19. What is remarked of fruits?
20. What of substances used as relishes to other food?
21. What is said of the use of coffee, tea, and cocoa?
22. What of alcoholic drinks?
23. What is said of preparing food by cooking?
24. What is said of the different modes of cooking meats?
25. What of the trichina spiralis?
26. What is said of the quantity of food required by a person?
27. What is said of the food for dyspeptic persons? What does habit often induce us to do?
28. How is the system affected when it does not receive enough nourishment? How does the want of food affect children?
29. What is said of food for children?
30. What is said of regularity in eating?
31. What of eating too rapidly?
32. Why not take a hearty meal just before or after severe labor?
33. How does the mind influence digestion?
34. How does pure air affect the appetite?

SECTION VI.

SLEEP.

1. *The brain, which is the centre of the nervous system, is constantly in a state of activity during the day.* Even when not engaged in mental labor, it is still subject to impressions from surrounding objects; hence, it is never quiet

while the individual is awake. From this continued excitement during the day, the nervous system becomes exhausted and needs repose. This it obtains by sleep; during which time its functional powers are renewed, and it is prepared for the work and the pleasures of another day.

2. *Although the mind is inactive, and the muscles are in a state of rest during sleep, yet the important vital processes are still going on in the body.* During the active exercise of the system, the vital force is consumed more rapidly than it is produced, so that both body and mind become weary towards the close of day; but during the season of sleep, the nutrient vessels continue at work supplying life force, so that the morning finds the system refreshed and fully restored to its usual vigor.

3. *The functions of the vital organs continue during sleep, yet they are less active than when we are awake.* The voluntary muscles are in a state of repose, the respiration and circulation are reduced, the body is somewhat lowered in temperature, and the process of digestion is less vigorous, so that every part of the system is partially, or wholly in a state of rest.

4. *When the amount of sleep is insufficient, this building up process is not completed;* yesterday's labor is not fully compensated for, and the drain it made upon the life force is not entirely replenished; thus the individual enters upon the work of another day, below the proper standard of life and strength, and must, as a matter of course, be so much the more depressed by the time that night comes again. If this system be continued, it is easy to understand how the powers of life will surely ebb away, and the body, once so full of life and vigor, be shorn of its strength, and reduced to a hopeless wreck.

5. *Diseases, both physical and mental, follow the continued loss of sleep.* Debility of the system, nervous excitability, disturbed breathing, palpitation of the heart, and dyspepsia, with its long train of evils, are a few of the diseases of the body; while insanity, particularly in those who are perform-

ing excessive mental labor, is not an uncommon result to the mind.

6. *Diseases, both physical and mental, result from too great indulgence in sleep.* The whole nervous system becomes dull, the sensations are blunted, the mind acts sluggishly, the memory is impaired, the physical energy is depressed, and the functions of all the organs become more or less torpid, when we indulge in sleep to excess.

7. *About eight hours out of the twenty-four is the time usually assigned for sleep.* The amount of time, however, required for restoring the wasted energies, must depend upon the activity, the health, and the habits of the person. Women require more sleep than men; and persons advanced in age, need more sleep than those in middle life.

8. *Children require more sleep than adults.* Their nervous systems are more excitable, and while awake, they are scarcely ever at rest, so that they become more fatigued during the day, and need a longer period of repose, in which to renew their exhausted energies.

9. *Night is the proper period for sleep;* yet it is too often the habit to convert the night into day, by those who indulge in the social customs of society. A regular hour for retiring to rest should be adopted. This should not be later than ten o'clock, as there is truth in the old adage, that "one hour's rest before midnight is worth two after." It is probable, however, that irregularity in the hours of rest, is the prominent cause of mischief.

10. *A full supper just before retiring to rest is apt to disturb the sleep, and to produce dreams.* When the digestive powers are somewhat feeble, a light meal will always prove more wholesome, than to fill the stomach with solid food. Apples, shellbarks, and walnuts, are often eaten just before retiring; but such a course cannot be recommended.

11. *The sleeping-room should be large, airy, and well ventilated,* so that the atmosphere in it will not become much vitiated during the night. In the morning, the doors and

windows should be opened, so as to admit the fresh air, and the sunlight; but they should, however, except such as are needed for ventilation, be closed two or three hours before sunset, even in the most favorable weather.

12. *The kind of bed depends in a great measure upon the custom of the individual.* Any change in this custom, whether it be for a harder or a softer couch, will disturb the rest. A mattress is best for warm weather, and a feather bed for cold weather; yet many prefer a hair mattress for both winter and summer. Sleeping with the head too low, or without pillows, is often the cause of unpleasant dreams.

13. *A change of beds during the winter season is a fruitful source of colds.* The "spare bed," which may not have been occupied for days or weeks, is generally offered to the visitor. It is usually damp and cold; and when this is added to the damp and cold atmosphere of the room, a more unhealthy place for sleeping could scarcely be found.

14. *More covering is needed for the body when asleep, than when awake.* During sleep, the temperature of the body is lowered, and the skin relaxed, so that it is more susceptible to cold. The covering should be light, but warm; hence, woollen blankets are far preferable to the old-fashioned quilt or coverlet.

15. *Children should not sleep in beds placed upon or too near the floor.* The portion of air near the floor of a room is always the most impure and unhealthy. When an apartment is occupied by older persons, it becomes still more injurious for children to sleep in a low bed, in the same room. Two or three beds should never be crowded in the same room when it can be avoided.

16. *Persons who are well should not sleep in the same bed with those whose constitutions are much enfeebled by disease.* This applies more particularly to children, who should not sleep with persons advanced in age, or who are suffering from chronic diseases of the lungs, stomach, or other organs. A disregard of this rule has been the cause of much sickness.

QUESTIONS.

SECTION VI.

1. Why is sleep required?
2. How does sleep renew the vital energies of the body?
3. How does sleep affect the functions of the vital organs?
4. What effect does the want of sleep have upon the body?
5. What diseases follow the want of sleep?
6. What is the result of too much sleep?
7. How much sleep does the body need?
8. Why do children need more sleep than adults?
9. What time is best suited for sleep?
10. Why is a full supper injurious just before sleep?
11. What is said of the size and ventilation of a sleeping-room?
12. What kind of a bed is best? How are dreams often produced?
13. Why are "spare beds" usually unhealthy?
14. What is remarked of the covering during sleep?
15. Why are beds on or near the floor unhealthy?
16. What is said of the sick and the well sleeping in the same bed?

SECTION VII.

EXERCISE.

1. A judicious system of exercise is needed to produce the best and fullest development both of the body and the mind; which, when thus developed, require the continuance of the exercise to keep them in a healthy condition. Every function will then be properly performed, and the health of the individual will be unimpaired. Such exercise will be most beneficial when it calls into activity every part of the system; yet there are few, if any, of the vocations of life that call forth this general activity, hence, a portion of each day should be devoted to such exercise as is best adapted to the individual.

2. *The object and aim of all exercise should be to bring into*

action those parts, either of the mind or of the body, which are not sufficiently exercised in the pursuits of life. Any plan of exercise based upon this view will be appropriate and beneficial; therefore, the means used for exercise must vary according to the individual; and in each case should be directed by wisdom and intelligence. When properly used, there is no means of more importance in developing and strengthening both body and mind, than that of exercise; and, when improperly used, none more injurious.

3. *Exercise of the body may be active or passive.* Active exercise is made by calling into action the voluntary muscles of the body, as in running and walking; but passive exercise is that occasioned by the movements of other bodies, as when riding in a carriage, or sailing in a boat.

4. *Active exercise, in proper amount, adds to the firmness and elasticity of the muscles, and increases them in size and in strength.* To be of much use, it must be continued for a long time; because the process of restoring strength to weak and exhausted muscles, goes on very slowly.

5. *Active exercise increases the movements of the heart, and causes a greater flow of blood through all parts of the body.* Thus, an increased supply is sent to renew the strength of the muscles, and to carry away the waste material, and this corresponds with the amount of exercise. In diseases, where the passage of the blood is obstructed, as in some affections of the heart and the brain, exercise may be injurious by sending too much blood to the part affected.

6. *Active exercise invigorates the function of digestion.* It increases the appetite and stimulates the digestive organs, so that a larger amount of food is digested, and the system receives an increase of nourishment, which adds to the weight of the body and gives tone and strength to all parts of the system. This is the case when the exercise is moderate; but when it produces great fatigue, the digestive organs partake of the general depression of the system, and are less able to perform their functions.

7. *Exercise not only quickens the pulse, but hastens the breathing.* When this takes place in pure air, a larger amount of oxygen will be supplied to the blood, and the carbonic acid will be more effectually removed; thus will the system be invigorated, and all parts will respond, by an increased energy of action.

8. *Active exercise of every kind must be followed by a season of repose;* therefore, some physiologists have recommended that eight hours be allotted to sleep, eight hours to work, and eight hours to recreation. When the hours for work are spent in manual labor, at least a portion of those for recreation should be employed in improving the mind; but when the working hours are devoted to mental labor, a portion of the period for recreation should be used to develop the physical strength.

9. *Exercise will prove of but little use, unless continued for some time;* because health and strength are the result of a very gradual growth. The amount of exercise at any one time, must be such as to suit the strength of the individual; it must always stop short of great fatigue, and it should be regular every day, or it will not produce beneficial results.

10. The beneficial results from exercise in the open air, are, that it accelerates the respiration, thus furnishing more oxygen to the blood; it quickens the circulation; it invigorates the nervous system; it stimulates the digestive powers to increased function, thus furnishing a large amount of nourishment, which the blood conveys to every organ of the system. These being stimulated by the presence of the richer blood, become more active in function, and are increased in size and vigor, so that the health and strength of the whole being are promoted.

11. *Excessive labor wears out the system by overtaxing its strength.* A limited amount of power only is supplied to the body by the food and drink; and when labor takes more from the body, than the body receives in the way of nourishment, such labor is always excessive, and will, if continued, destroy the life of the system.

12. *When young persons are required to labor hard, their vital energies are quickly exhausted.* The nourishment they receive from food and drink, is all consumed in performing their work, and none is left to develop and strengthen the organs of the body; consequently, they are stunted in their growth, and remain dwarfed in intellectual and physical strength.

13. *No child should ever be compelled or permitted to labor to its full capacity,* whether that labor be physical or intellectual; but a part of the vital, or life force, daily supplied by the food and drink, should be reserved in the system, so as to develop it to the highest degree of which it is capable.

14. *Whenever the vital energies of an individual, whether youth or adult, are overtaxed, the result is the same.* The system is depressed below the standard of health; thus preparing a foundation for numerous diseases, which, when once seated, continue to sap still more and more the health and strength of the body while life remains.

15. *All exercise should be taken in the open air;* for when the air is vitiated, the exercise is of but little value. More air may be inhaled; but when it does not contain a good supply of oxygen, it will impart but little vigor to the system.

16. *Children should have freedom of exercise in the open air.* This should be in such harmless yet exhilarating sports as walking, running, riding, sailing, playing ball, spinning tops, and trundling hoops, which give motion to every part of the body without requiring much exertion of the mind.

17. *Walking is one of the cheapest, yet most beneficial means of exercise,* and is within the reach of nearly all persons. It brings into action the muscles of the neck, the trunk, and of the upper and the lower limbs. It is entirely under the control of the individual, and may be made either gentle or active, to suit the case.

18. *Jumping, as an exercise, is too violent,* and when long continued, as in "jumping the rope," is injurious. It is only adapted to the period of youth when the cartilages are

elastic, and the shock or jar to the system is, therefore, not so great. In jumping, the muscles of the legs are most used.

19. *In running, nearly every muscle of the body is brought into active exercise;* therefore, it very soon produces fatigue. It is most enjoyed by children; but it is so violent that they are apt to indulge in it to excess.

20. *When out-door exercise cannot be enjoyed, a substitute may be found* in the "physical exercises," such as are adopted in many schools, and in the discipline of the gymnasium. The object of these exercises should be to call into activity all parts of the body, so as to continue it in a state of health; or, when diseased, to promote the cure. Every possible means of amusement should accompany these exercises, so that both body and mind may receive the fullest benefit.

21. Wherever physical exercises have been introduced into our schools and colleges, the testimony is that they not only increase the physical activity of the students, but they also improve their mental condition, so that there is a more rapid advancement in their studies. A system of physical training should, therefore, be introduced into every educational institution, and the result would undoubtedly prove beneficial.

22. *In the public schools of our cities, the amount of time devoted to exercise, or to drills of any kind, is not sufficient* to preserve the health; and, indeed, the most of such exercises are not of a kind that serve to strengthen the muscles, or give vigor to the frame. They tend rather to relieve the monotony of the school-room, to relax the mind for a few moments, and to rest certain muscles by a change in the position of the body; and in this way they are productive of much good.

23. *The erect position is the best for the body; whether sitting, standing, or walking.* It requires less muscular exertion to keep the body erect than to retain it in any other upright position; for when it is bent forward, or backward, or to either side, many of the muscles are kept in a state of continued tension, causing more or less fatigue. An erect position not only favors the free movement of the muscles, but

it also affords the internal organs the fullest opportunity to perform their functions.

24. *A stooping habit should be overcome, if possible, while the person is young.* When the body is distorted from its natural shape in youth, it is apt to remain so through life, much to the disadvantage, if not to the positive injury, of the individual; but every possible means should be used by a regular system of training to correct the deformity.

25. *The period of youth should be devoted partly to mental culture;* but most attention should be given to developing and strengthening the system. The body needs much care during this period of growth, and other things should be made to serve its purpose. During the first six years of life, no study should be required; in the seventh year, two hours daily may be devoted to books; in the eighth year, three hours; in the ninth year, four hours; in the tenth year, five hours; and after that, six or seven hours daily may be spent in study.

26. *Seats for children, whether at home or in the school-room, should have a resting-place for the feet,* or should be low enough for the feet to rest upon the floor. This will support the weight of the legs, and will add much to the comfort and the health of the child. All seats, whether for children or for adults, should have backs as a support for the body.

27. *Riding on horseback requires more exertion than any of the other passive kinds of exercise.* All the muscles of the body are brought into use to preserve the equilibrium of the rider during the different movements of pacing, galloping, and trotting. For a moderately strong person, it is one of the best means of exercise, admitting of an agreeable change of air and scenery, and keeping the mind pleasantly occupied. For the weak and feeble, it is not so well suited, and should not be attempted by them unless the horse is very gentle and can be easily managed.

28. *The exercise from riding in a vehicle depends upon the character of the vehicle used.* A rough, jarring wagon will

give exercise to most of the muscles; but it is only suited to those who are comparatively strong; while an easy carriage, by its gentle motions, is suited to the convalescent, the feeble, the delicate, and the aged.

29. *Sailing or riding in a boat is a very pleasant, as well as useful means of exercise,* on account of the continued change experienced. Frequent excursions on the water, during the summer season, afford a most delightful recreation to all who are confined much within doors; and are always very invigorating, particularly to the women and the children of our large cities.

30. *Active exercise is not advisable after a full meal,* as it tends to draw the strength from the digestive organs to the muscles, which are brought into action; but when the food is partly digested, and the stomach is, in a measure, relieved of its burden, labor may then be performed without disadvantage.

31. *When a person neglects to take proper exercise, all parts of the system languish.* The muscles lose their firmness and strength, the nervous system becomes easily excited, the vital functions act sluggishly, the powers of digestion and nutrition become feeble, and thus, the foundation for prolonged nervous disorders is laid as the result of sedentary habits.

32. *Literary occupations are not especially injurious to health, unless they be pursued to excess,* and the other means, which are always essential to the preservation of the health, be neglected. Sedentary occupations of all kinds, are apt to induce dyspepsia; but the addition of mental labor does not seem to increase the tendency to that disease.

33. *Few persons perish from pure mental exhaustion alone;* and it is very doubtful whether the pupils of our schools suffer so much from this cause, as is sometimes imagined. During an experience of nearly twenty years in the schoolroom, we have met with but a limited number of cases injured by overstudy; yet we have seen very many whose

systems have been more or less broken, by the neglect of a proper *hygiene*, both in and out of the school-room, and during the hours of sleep.

34. *The amount of study required in our institutions of learning is not too great*, unless the pupil is already enfeebled by disease; providing the proper care is used to preserve the health by regular habits of eating, sleeping, and by using such exercise as the case needs. Without these, the body will not long remain in health, even when the mind is unemployed; with them, the mental labor will seldom prove injurious.

35. *Continued application to study, without recreation or amusement, will in time produce nervous disorders.* Mental labor, like everything else, becomes a vice, when carried to excess. The mind needs repose as well as the body; therefore, it is the part of wisdom frequently to join in cheerful company, and to engage in such exercises as will divert it from its ordinary channels of thought; for in this diversion the mind finds appropriate rest.

QUESTIONS.

SECTION VII.

1. What is remarked of the need of exercise?
2. What should be the object of all exercise?
3. What two kinds of exercise may be used?
4. How does exercise affect the muscles?
5. How does exercise affect the circulation?
6. How does exercise affect digestion?
7. How does exercise affect the breathing?
8. What should always follow active exercise? How may the twenty-four hours be divided?
9. What is said of regular exercise?
10. What are the results of exercise in the open air?
11. How does excessive labor affect the body?
12. How does hard labor affect the young?
13. Why should the labor of a child be limited in amount?

14. What always results from overtaxing the vital energies?
15. Why should all exercise be taken in the open air?
16. What is said of the sports of children?
17. What is remarked of walking, as a means of exercise?
18. What of jumping?
19. What of running?
20. What substitute is there for out-door exercise? What should be the object of all physical exercises?
21. How are physical exercises in schools beneficial? Why should they be introduced into all institutions of learning?
22. What is said of exercises in the public schools of cities?
23. Why is the erect position the best for the body?
24. What is remarked of a stooping habit?
25. To what should the period of youth be devoted? What is said of the time for study during youth?
26. What is remarked of seats used by children?
27. What is said of riding on horseback as a means of exercise?
28. What of riding in a vehicle?
29. What of riding in boats?
30. What is said of exercise after a full meal?
31. How does a neglect of exercise affect the system?
32. What is remarked of literary occupations? What of sedentary occupations of all kinds?
33. What is remarked of overstudy in schools?
34. What is always needed for health, whether the mind is employed or not?
35. What is the effect of continued application to study?

SECTION VIII.

THE TEETH AND OTHER ORGANS.

1. *The teeth should be cleansed after each meal,* so as to remove all particles of food from the mouth and the teeth. This may be done by the tooth-brush, aided by tooth-picks, made of wood or the common goose-quill. When the particles of food are not removed, they soon putrefy, and in that state render the breath offensive, as well as hasten the decay of the teeth.

2. *The enamel is a natural protection to the body of the tooth.* When any portion of it is destroyed, the part of the tooth thus exposed to the air soon decays. Very hot or very cold substances crack the enamel, and should be avoided, as well as all substances that break or scratch it, such as gritty tooth-powder, the shells of hard nuts, and metal tooth-picks.

3. *When the permanent teeth are irregular from being too much crowded, one or more of them should be removed.* This will improve their appearance, and will prevent them from pressing so closely together as to cause injury to the enamel. When any part of the enamel is injured, and the tooth has commenced to decay, it should be filled with gold-foil. In this way a tooth partly decayed may be preserved for many years.

4. *The eye, like all other organs of the body, needs rest.* When too long used, it becomes wearied, the retina is exhausted of its sensibility, and the clearness of vision is obscured. This is particularly the case when the eye is much used by lamp-light, as when we are engaged in reading, and in sewing at night. The black and white colors of a printed page, exhaust the eye more quickly than when it is engaged upon the softer colors, such as yellow, blue, or green.

5. *Sudden changes in the amount of light should be avoided.* The iris contracts or dilates, so as to regulate the quantity of light falling upon the retina; but when the change from a dim to a very strong light is made before the iris can contract, the retina is overpowered; and when this is continued, the loss of sight sometimes follows.

6. *The eyes should be bathed in tepid or cold water,* so as to remove the dust and the secretions from their inner angles, and also from the roots of the eyelashes. When the eyes are inflamed, they may be frequently bathed in tepid or cold water, or the water may be constantly applied to them; but no *eye-washes,* of any kind, should ever be used, unless prescribed by a physician; because permanent injury to the eyes has frequently followed their use.

7. *When the hearing is impaired, a skilful physician should be consulted, and his advice followed.* All nostrums for the cure of deafness should be ignored. When the external ear is dry, and the wax in it becomes hard, which is frequently the case with persons who are confined much within doors, relief may be obtained by putting one or two drops of rabbit's fat, goose-grease, sweet-oil, or glycerine, in the ear.

8. The tympanic membrane between the external and the middle ear entirely closes the external auditory canal, and thus *prevents insects and other things from passing to the brain.* When an insect crawls into the external canal, a few drops of oil or fat should be dropped into the ear. This will kill the insect immediately, by preventing respiration; and it may then be removed from the ear.

9. *The head should not be kept too warm.* The custom of wearing the hat while in the house, is believed by many physicians to produce baldness. In children, the hair should be kept *short and thin;* because a luxuriant growth of hair invites an undue amount of blood to the brain, causing weakness of the eyes, headache, and other diseases.

10. *Hemorrhage from wounds should be checked as soon as possible.* When the blood comes from a vein, it will flow in a regular stream; but when it comes from an artery, it will flow in successive jets. In either case it may be checked, by means of pressure, until a surgeon can be obtained.

11. *When the bleeding artery is small, a piece of muslin or linen should be folded up and bound firmly on the wound;* but when the artery is larger, pressure should also be made on its main trunk, either by grasping the parts so that the fingers will press on the artery, or by using a key padded at one end. When the pressure is to be continued, a handkerchief may be used in the following manner: First, make a knot in the middle of the handkerchief; then tie it loosely around the limb, so that the knot will press upon the artery. Next, place a short stick under the handkerchief; then twist it until the bleeding is stopped.

12. *When the hemorrhage is from the small vessels,* an im-

portant part of the treatment is the formation of a clot in the wound, which serves to check the further flow of blood. This may generally be accomplished by binding several thicknesses of muslin or linen, or a quantity of lint, tightly on the wound; or by applying to it lint wet with very cold water, or with a solution of alum and water. Powdered alum may also be applied.

13. *Sunlight is needed for the healthy development of the human frame.* It is as essential to the vigor of animal as of vegetable life. Our dwelling-houses should be built so as to admit plenty of sunlight; for when the sun's bright rays are excluded from a room, it becomes dark and damp, and serves to generate disease in those who occupy it. When children are confined in dark places, such as mines and manufacturing establishments, they are pale and sickly-looking, and are often stunted in their growth, or are otherwise deformed. When adults are deprived of light, the skin becomes blanched, so as to present a white appearance; and they lose more or less of their vigor and activity.

14. Persons in feeble or delicate health, will be invigorated by spending a part of each clear day where the sun's rays can shine upon them. During the warm weather of summer, it would be far better for invalids to sit in the sun's rays than to seclude themselves in darkened rooms, under the plea of keeping cool. During the pleasant weather of winter, they should put on plenty of clothing and sit for an hour or two each day on an open portico in the sun; and when the weather is very severe, they should sit in a comfortable room so that the sun can shine through a window on them.

15. The human body is a complicated piece of mechanism, most admirably adapted by an All-wise Creator to the duties required of it; and the more we investigate and rightly come to know of our own existence, and of these frail bodies, which must soon return to dust again, the more will we desire to offer up to Him, who is Ruler over all, the homage of a grateful heart!

QUESTIONS.

SECTION VIII.

1. What is remarked of cleansing the teeth?
2. What is remarked of the enamel of the teeth?
3. What of the teeth when too much crowded? What of filling the teeth?
4. How does continued use affect the sight? Why does reading exhaust the eye?
5. How do sudden changes of light affect the eye?
6. Why is bathing the eye in water beneficial? What is said of the use of eye-washes?
7. What should be done when the hearing is impaired? How may dryness in the ear be remedied?
8. What is remarked of insects in the external ear?
9. Why should the hat be removed while in the house? Why should children have their hair kept short and thin?
10. What is remarked of hemorrhage from wounds?
11. How may hemorrhage from large vessels be checked?
12. How may hemorrhage from small vessels be checked?
13. What advantage is derived from plenty of sun-light?
14. How may feeble persons be invigorated? Where should they sit in summer? In winter?
15. What remarks are made about the human body?

CHAPTER VI.—Development and Death.

SECTION I.

GROWTH AND DEVELOPMENT.

1. *The average weight of the human infant* at birth is from six to seven pounds, and the height about eighteen inches. The growth of the body, in height, is rapid at first, but it afterwards becomes more gradual. During the first three years the body of the child reaches to one-half the height of the adult; but eighteen or twenty years are afterwards required before the full stature is attained. The average height of men in the United States, is about five feet seven inches, and of women, about five feet two inches. The growth of the body, in weight, continues until about the thirtieth year, at which time the average weight of men is about one hundred and forty-four pounds, avoirdupois, and of women about one hundred and twenty-three pounds.

2. At first the infant is entirely helpless; it takes no notice of the things about it, and it spends most of the time in sleep; but as it grows older, it takes more and more notice of surrounding things, and it soon learns to communicate its wants to others. At six months of age the child can lisp a little, and by the end of the first year it can imitate a few simple sounds of one or two syllables.

3. *The skeleton of an infant is soft and yielding;* hence, it has but a limited amount of strength. Many of the bones

are in the form of cartilage; but they continue to ossify, or change into bone, and thus add to the strength of the child. When three months old, the healthy infant has strength enough to support its head, and keep it from falling forward upon the chest; when four months old, it can sit upright; when nine months old, it can crawl about the room; when a year old, it can stand alone by taking hold of a chair, or other support; and at various periods, between one and two years of age, it becomes able to walk, and even to run alone.

4. At birth, the *bones of the skull* are very thin and flexible, and their edges are not yet united, so as to form the sutures. The bones are held together by fibrous membranes, and by the skin, so that the skull is comparatively soft and yielding, and is not a solid, bony case, like that of the adult.

5. In the line of the sutures are several membranous spaces, covered by the skin and other soft tissues, and these spaces are called *Font'anels.* The most important of these is the anterior fontanel, which is situated at the top of the skull, where the angles of the frontal and the parietal bones come together; and the posterior fontanel, which is situated at the crown of the head, where the angles of the parietal bones meet with the occipital bone. These fontanels are not entirely closed until the child is about *four years of age.*

6. *Each vertebra* is developed from three points of ossification, one of which is in the body of the vertebra, and one to each side of the arch. At birth, however, the vertebræ are composed almost entirely of cartilage; and the spinal column is then too weak to maintain the body in an upright position.

7. *The pelvis* is at first mostly cartilaginous, and the hip-bone on each side is composed of three separate pieces. These meet in a triangular union in the acetabulum, or cavity of the hip-joint. The bones of the upper and the lower limbs are ossified only in their middle portion, at the time of birth; hence, they are soft and flexible, and are unable

to sustain the weight of the body, or to bear much muscular exertion.

8. *The function of respiration* is at first very imperfectly performed; the lungs are not fully expanded, and the air does not find its way into all the air vesicles until the child is several days old. The skin, however, is very thin and delicate, and it is probable that respiration takes place through it. At first, the number of respirations is from forty to fifty per minute; at the age of five years, about twenty-six per minute; and in the adult, about eighteen per minute.

9. *The function of digestion* is exceedingly active in children. They need nourishment, not only for the support but also for the growth and development of their bodies; hence, their powers of digestion and of assimilation are very strong. They eat unripe fruit and other unpalatable articles of food with considerable relish, and they require more food and at shorter intervals than when they become adult men or women.

10. *The teeth* begin to appear within the first year. The front, or incisor teeth, both upper and lower, are usually through the gums at the age of seven or eight months; and one molar tooth is through, on each side of each jaw, by the end of the year. At eighteen months the canine, or stomach and eye teeth, appear; and at two years of age, two other molar teeth are added to each jaw, making twenty teeth in all. The teeth then consist of four incisors, two canines, and four molars in each jaw. They are called the temporary or milk teeth, and are followed by the second set, or permanent teeth.

11. *The rudiments of the second as well as of the first set of teeth exist in the jaw at the time of birth*, although they are not visible. The second set of teeth grow very slowly until about the sixth year, when they increase more rapidly in size, and soon push their way towards the surface of the gum; thus pressing against the milk teeth, which become detached and fall from their sockets in the jaw. The per-

manent teeth are harder in texture and mostly larger in size than the temporary set. They are also more numerous, and number thirty-two, instead of twenty; and the jaws have both increased in size so as to accommodate this larger number.

12. The permanent teeth usually appear in the following order: In the sixth and seventh years, the first molar teeth, and in the seventh and eighth years, the incisor teeth appear. In the ninth and tenth years, the two molars of the first set give place to the two bicuspids of the permanent set; and in the twelfth year, the canine teeth of the first set are replaced by the canines of the second set. In the thirteenth and fourteenth years, the second molar teeth protrude from the jaw; and from the seventeenth to the twenty-second year, the last molar, or wisdom teeth, appear and complete the permanent set.

13. Human life has been divided into periods which may be thus distinguished. From birth to the appearance of the first tooth, in the seventh month, is the period of *infancy;* from the appearance of the first tooth to the time when the temporary or milk teeth begin to fall out, in the sixth or seventh year, is the period of *childhood;* from the time when the temporary teeth begin to fall to the final completion of the stature, in the eighteenth or twentieth year, is the period of *youth.* Then comes the period of *maturity,* or the *prime of life;* after which the powers decline, and the last period of human life, that of *old age,* is reached.

QUESTIONS.

SECTION I.

1. What is the weight and height of the human infant? What is said of the growth of the body in height? What of its growth in weight?

2. What is the condition of the infant at first? What of its learning to talk?

3. What is said of the skeleton of an infant? What of its increase in strength?
4. What is said of the bones of the skull?
5. What is said of the fontanels?
6. What of the development of the vertebræ?
7. What of the development of the pelvis?
8. What is said of the respiration in children?
9. What of the digestion in children?
10. What is said of the appearance of the first set of teeth?
11. What of the development of the second set of teeth?
12. What of the time and order of cutting the second set?
13. What are the periods into which human life has been divided?

SECTION II.

DECAY AND DEATH.

1. The loss, from the "wear and tear" constantly going on in the living body, must be repaired, and the parts destroyed by accident must be reproduced, so that the functions of life can be properly performed. *Reparation* is necessary to the existence of every living organism, animal and vegetable. As a general rule, the lower the type of animals, the greater is the inherent power of reparation; yet all animals possess this power in a greater or less degree.

2. In some of the lowest orders this power is very great; for when the *hy'dra*, a species of jelly-fish, is cut into pieces, each piece becomes developed into a perfect hydra; and this process may be repeated again and again with similar results. The *Crusta'cea*, which include the lobsters, crabs, and shrimps, and the *Arach'nida*, which include the spiders and the scorpions, can, when fully developed, reproduce their limbs; and the *common snail*, it is asserted, can reproduce its head if the cerebral ganglion be preserved uninjured. The *newt*, *a small lizard*, can readily reproduce an eye, an entire limb, or its tail, whenever it loses any of these organs.

3. This process of reparation is most active in animals during the earlier periods of existence; and it gradually diminishes as life advances, so that parts which are lost or injured in old age are imperfectly repaired or reproduced, although the same injury might easily be repaired in the young.

4. *In man and other warm-blooded animals the power of reparation is limited to certain tissues.* The epidermis of the skin, the epithelium of the mucous membranes, and also the red corpuscles of the blood, are constantly undergoing decay and reparation in the nutritive processes which are going on in the body all through life.

5. The tissues of the body, which are simple in structure and low in vitality, are capable of reparation; and these are the bones, and the elastic, the fibrous, and the connective tissues. Besides these, the blood-vessels, the lymphatic vessels, and the nerves, are also endowed with this power.

6. Tissues which are complex in structure, or are endowed with peculiar functions, such as true cartilage, muscles, and gray nerve-substance; and the special organs, such as the dermis and its glands, and the secreting and excreting glands or organs of the body, have not the power of reparation.

7. *Cartilage*, when broken across, or when removed by accident, is not repaired; but the separated parts become united by strong, fibrous or bony belts. *Bones*, when injured or broken, are repaired with remarkable facility. When the fibres of a *muscle* are divided, and the cut ends are not too far from each other, they are united by a band of connective tissue, and thus its functions are re-established; but when the ends are kept too far apart to be thus united, the muscle decreases in size, and soon undergoes fatty degeneration. A divided *nerve* is quickly united by connective tissue; and nerve-fibres are afterwards formed in this so as to establish the nervous connection.

8. *Life and death* are continually taking place in every organized being. Every tissue, every organ, and indeed

every part of the body is subject alike to decay. The cells from which they are developed have their allotted period of existence, and must then be removed from among the living where they can be of no further use. Other cells must be formed to take their places, and thus preserve the life of the individual. In these respects the body, which is made up of many parts, is like a community of persons. Death is constantly at work in the community, and one by one they pass from the stage of existence, while life is equally busy bringing others upon the stage of action to occupy their places.

9. The relative powers of life and death vary with the different periods of human existence. *In childhood and youth*, the powers of life are so strong and the nutritive system so full of vigor, that the natural waste and decay in the system is repaired, and new material for the growth and development of the individual is abundantly furnished; therefore, all parts of the body increase in size and strength during these periods of life.

10. *In the prime of life*, the skeleton has become strong and solid, the full stature of the individual has been attained, the system has reached its fullest development, and the intellectual powers their highest perfection. The powers of waste and assimilation are now evenly balanced, and the individual neither gains nor loses for a term of years.

11. As we pass the meridian of life and approach the period of *old age*, the powers of life become more and more feeble; they no longer keep pace with the powers of death, and, therefore, are unable to repair the natural loss sustained by the tissues and organs of the body. These organs, consequently, undergo a degeneration, their functional powers are daily diminished, and life ebbs slowly away until at last the body, having lost all vitality, is laid in the "narrow house" appointed for the dead, and the immortal soul returns to Him from whence it came!

QUESTIONS.

SECTION II.

1. What is said of the loss from the wear and tear in the body?
2. What is said of reparation in the lower order of animals?
3. What is said of reparation at different periods of life?
4. What of it in man and other warm-blooded animals?
5. What parts of the body are capable of reparation?
6. What parts are without the power of reparation?
7. What is said of repairing cartilage? Of repairing bones? Of repairing muscles? Of repairing nerves?
8. What is said of life and death in organized bodies?
9. What is said of these powers in childhood and youth?
10. What of them in the prime of life?
11. What of them in old age?

CHAPTER VII.—Appendix.

SECTION I.

CARE OF THE SICK.

1. *Good nursing is an important part in all cases of sickness.* Intelligence, good judgment, and a willingness to do, are among the requisites of a good nurse. Kindness and gentleness towards the sick, and a disposition to soothe and comfort, by giving attention to the patient's wants, whether real or imaginary, will do much to allay the nervous condition, so common in cases of severe illness.

2. *Near and dear friends sometimes render themselves almost unfit for nursing*, on account of the anxiety they exhibit for the welfare of the sick. In all cases, a nurse should preserve a calm demeanor, and without any outward exhibition of fear or sorrow, perform the duties needed by the patient, trusting to that higher "Arm of Power" upon which we must all lean for support amid the many trials in this life!

3. *The most comfortable and cheerful room in the house should be selected for the sick.* A large, airy room, as far from noise as possible, and one in which the sunlight can enter, will be best. Superfluous furniture should be removed, so as not to incommode the attendants.

4. *The temperature of a sick-room should be kept between sixty and seventy degrees.* The room should be well ventilated, so as to be kept free from all unpleasant odors, and

from all impurities. An open fire-place, or chimney-place, is an excellent means of ventilation. Currents of air should never be permitted to blow upon the patient. Offensive matters should be removed immediately, and every precaution taken to keep the air of the room pure. For warming the room, wood is preferable to coal.

5. *The best means for lighting a sick-room at night, is by sperm candles,* or by tapers which burn in sperm-oil. Coal-oil, and most other preparations used for giving light, emit an unpleasant odor, often very disagreeable to the patient.

6. *In all cases of sickness, the patient needs rest, and the sick-room should be kept quiet.* No more of the attendants should enter the room than can be of service while there. Visitors more or less disturb those who are sick; hence, their admission, or otherwise, should be as directed by the physician. All bustling, all confusion, and all unnecessary talking, should be avoided; and stillness should reign in the sick-room.

7. *Cleanliness is important in every sick-room.* Cups, tumblers, and other vessels containing food, drink, or medicine, should be frequently washed. Both the dress of the patient and the bed-linen become soiled sooner in sickness than in health, and should, therefore, be more frequently changed.

8. *Those who wait upon the sick should take their meals regularly* through the day; and during the night they should also partake of sóme light food. They should wear plenty of clothing, so as not to feel cold, particularly towards morning, when the system is exhausted.

9. *Those who nurse through the day should not watch at night;* because the system is then too much wearied for want of sleep. It is important that the watcher keep awake, so as to attend to the wants of the sick; she should, therefore, obtain plenty of sleep during the day.

10. Whatever is likely to be needed during the night, should be brought into the sick-room before the family

retires to rest; then, neither the slumbers of the patient, nor of the family, will be disturbed by a search for needful articles during the night.

11. *The nurse should be careful to follow the directions of the physician,* both in giving medicines, and in giving food and drink. Medicines must be given properly, or they will often fail in their beneficial effects. Food and drink also have much influence on those who are sick, and should be given with judgment. The preparation of food is of so much importance, that we add a few modes for preparing nourishment for the sick and the convalescent.

12. **Toast Water.** Toast a slice of stale bread until brown, without scorching, put it in boiling water, and cover closely until it is cool. Ice may be put in if desirable.

13. **Rice Water.** Take one tablespoonful of rice and one quart of water, boil them for an hour, and add a little salt, or some nutmeg and sugar.

14. **Limewater and Milk.** Mix equal quantities of limewater and fresh milk. One tablespoonful is a dose.

15. **Chicken Broth.** Take part of a chicken, with the skin removed, and place it in cold water along with some salt and a little rice. Boil slowly two hours and skim well.

16. **Panada.** Toast two slices of stale bread until brown, lay them in a dish and sprinkle with salt. Pour on a pint of boiling water, add a little nutmeg, and leave until cool.

17. **Arrowroot.** Stir a tablespoonful of arrowroot in a pint of boiling water, and boil a few minutes. Sweeten to the taste. A little lemon-peel to flavor, and wine or brandy to strengthen, may be added when needed. Milk may be substituted for the water.

18. **Essence of Beef.** Cut a quantity of lean beef into small pieces, put it into a strong bottle, without water, cork it loosely so that the steam can escape, and immerse the bottle to its neck in a vessel of cold water. Place on the fire and boil for two hours; then pour off the essence.

19. **Beef Tea.** Take a pound of lean beef, cut in very small pieces, add a pint of cold water, and boil slowly for half an hour. Skim off the fat, salt to taste, and pour off as needed.

20. **Wine Whey.** Add a wineglassful of Sherry or Madeira wine to half a pint of fresh milk while boiling. Strain through thin muslin, and add sugar and nutmeg.

21. **Brandy Punch.** Sweeten a tumblerful of fresh milk, and add a tablespoonful of brandy.

ASPHYXIA FROM DROWNING.

22. **The treatment for asphyxia,** or suspended breathing, whether from drowning, coal-gas, or other causes, is much the same.

1st. If the weather be not too severe, treat the patient instantly on the spot and waste no time in moving him.

2d. Loosen everything about the neck and the chest.

3d. Turn the patient on his face, and draw the tongue gently forward so as to clear the mouth. Cleanse the nostrils.

4th. Lay the patient on his back; raise his arms above the head, and at the same time draw up the shoulders; then bring them both down again. This should be repeated from fifteen to twenty times in a minute. Blow into the mouth, or nostrils, through a tube or a quill, or without them, as is available. Continue this as long as there is hope of exciting respiration.

5th. Pass a vial containing hartshorn under the nostrils, at intervals, so as to excite nervous action.

6th. When respiration is established, endeavor to induce warmth and circulation by rubbing the patient vigorously, and always one way, from the extremities towards the heart, so as to aid the return of the venous blood. The application of mustard, of bottles of hot water, and of heated

bricks to the feet and legs, and rubbing these parts with hot liquor, will be found useful.

7th. Cover the patient with dry clothing as soon as possible; dry blankets are preferable, so that friction may be continued under them.

DISINFECTANTS.

23. **Ventilation and cleanliness** are the best means of preventing the spread of infection. Unhealthy places may, however, be purified temporarily by disinfectants.

24. **Dwelling-houses** may be purified by thorough ventilation, by whitewashing the walls, and by sprinkling the floors with a solution made of half a fluidounce of carbolic acid and two quarts of water, or, by placing the solid chloride of lime, or common unslaked lime, in shallow vessels in the rooms. Pieces of charcoal are also useful by absorbing gases and other impurities.

25. The following disinfectants are the best for all other places that need purifying. A liquid composed of one fluidounce of Labarraque's solution of chlorinated soda, and one quart of water; or a solution made by adding ten grains of the permanganate of potassa to one quart of water; or one made of half a fluidounce of carbolic acid and two quarts of water; or a pound of the sulphate of iron dissolved in a gallon of water; or a pound of the chloride of lime, well mixed with a gallon of water, and used freely. Tar and the common petroleum are also good disinfectants.

26. **Articles of clothing from patients** should be thoroughly boiled. A solution of an ounce of the permanganate of potassa to three gallons of water is frequently used for this purpose. Clothing and bedding that cannot be washed, should be kept for several hours in an oven heated to a temperature of over two hundred degrees. In bad cases of con-

tagious disease, the clothing and bedding should either be burned or buried.

27. **Heaps of filth should be removed**; and when this cannot be done, they should be covered with charcoal two or three inches deep. Sewers, drains, and gutters, may be disinfected by using chloride of lime, which should be placed in them in small quantities. One pound of the chloride of lime will disinfect a thousand gallons of running filth.

POISONS AND THEIR ANTIDOTES.

28. **Cases of poisoning** occur so frequently, that the more common antidotes for them should be generally known. As prevention is always better than cure, it would be well if every package, box, and bottle, were plainly labelled, so that its contents could be positively known. Care in this respect would prevent many cases of accidental poisoning.

29. *In all cases where poison has been swallowed, the stomach should be relieved of its contents as soon as possible.* Vomiting may be speedily produced by drinking one or two tumblerfuls of warm water containing a tablespoonful of ground mustard, or of common table-salt. Copious draughts of warm water should be continued, and the throat may be irritated by the finger, or by a feather, so as to induce vomiting. After vomiting has commenced, warm mucilaginous drinks, such as flaxseed-tea, gum-arabic water, and slippery-elm water, should be taken, so as to continue the vomiting until there is reason to think the poison has all been expelled. A stomach-pump may be used for the same purpose.

30. After the vomiting, the strength of the person may be supported, if necessary, by wine or brandy. But in all cases of suspected poisoning, the services of a physician should be obtained as quickly as possible.

POISONS.	ANTIDOTES.
Nitric acid (aquafortis). Muriatic acid (spirits of salt). Sulphuric acid (oil of vitriol).	*Calcined Magnesia* is the best; but chalk, soda (saleratus), lime, or soap, may be substituted. Take them in copious draughts of warm water, and take them quickly.
Oxalic acid.	Give lime-water freely.
Prussic acid. Oil of bitter almonds. Laurel water.	Drink one teaspoonful of the *water of ammonia* in one pint of water.
Ammonia (hartshorn). Potash. Strong lye. Soda.	*Lemon juice or weak vinegar.* These may be followed by sweet-oil, castor-oil, linseed-oil, or thick cream.
Nitrate of Potassa (saltpetre). Iodine.	An emetic of warm water and *mustard*, followed by oil or cream.
Alcohol. Spirituous liquors.	An emetic of warm water and *mustard;* or use the stomach-pump.
Arsenic. Cobalt (fly-poison). Scheele's Green.	Use a *stomach-pump quickly.* Give an emetic of warm water and mustard, and follow this by large doses of Calcined Magnesia. The antidote for arsenic is *hydrated peroxide of iron.*
Antimonial wine. Tartar emetic.	A solution of *nutgall, tannin, or oak-bark*, is an antidote.
Sulphate of copper (blue vitriol). Acetate of copper (verdigris).	Milk, the *white of eggs*, or baking soda, is an antidote. Give mild drinks freely.
Acetate of lead (sugar of lead). White lead.	Use an emetic of water and mustard, or common salt, and follow by Epsom Salts. *Sulphuric acid* is an antidote.
Nitrate of silver (lunar caustic).	Give a teaspoonful of *common salt* in a tumblerful of water.
Corrosive Sublimate (bug poison). Red Precipitate. White Precipitate. Vermilion.	Give the *white of four or five eggs;* or, as a substitute, give wheat flour mixed with soap-suds, or with milk and water.
Phosphorus. Matches.	Large doses of *Calcined Magnesia*, followed by mucilaginous drinks.

POISONS.	ANTIDOTES.
Opium. Laudanum. Paregoric. Morphine. Godfrey's Cordial. Carminatives. Aconite (monkshood). Belladonna (nightshade). Hemlock. Lobelia. Stramonium (Jamestown Weed). Camphor. Tobacco. Nux Vomica (strychnine).	Produce *vomiting* by means of mustard and warm water, which should be continued for some time. Use the stomach-pump as quickly as possible. Keep the patient awake.
Poisonous food.	Give an *emetic* of warm water and mustard, or common salt.
Sting of Insects.	*Ammonia* (hartshorn) may be applied, or baking-soda made into a paste with water may be kept on the part.
Bite of Rabid animals.	Suck the part strongly; *burn out with caustic potassa, or a red-hot iron;* cut out the bitten part.
Bite of Rattlesnakes and other Serpents.	*Drink freely of whisky.* This is one of the best remedies known. Tie a ligature above the wound when it is on one of the limbs. Suck the part strongly with the mouth.
Poisonous gases.	Fresh air and artificial respiration.

QUESTIONS.

SECTION I.

1. What is said of good nursing? What of kindness to the sick?
2. Why are friends sometimes unfit to be nurses? How should a nurse always appear when in the sick-room?
3. What kind of a room should be selected for the sick? What is said of the furniture in it?
4. What should be the temperature of a sick-room? What is said of ventilation in a sick-room?
5. What is said of lighting a sick-room at night?
6. What is said of keeping the sick-room quiet?

7. What of cleanliness in the sick-room? What of changing the dress of the patient?

8. What is said of food for the nurse? What of clothing?

9. What is remarked of the watchers at night?

10. What preparation should be made before retiring to rest?

11. What is remarked of the directions given by the physician? What of the preparation of food?

12. How is toast water made? 13. Rice water? 14. Lime water and milk? 15. Chicken broth? 16. Panada? 17. Arrowroot? 18. Essence of beef? 19. Beef tea? 20. Wine whey? 21. Brandy punch?

22. What is the treatment for asphyxia?

23. What is said of ventilation and cleanliness?

24. How may dwelling-houses be purified?

25. How may other places be purified or disinfected?

26. What should be done with the clothing from patients?

27. What with heaps of filth near dwelling-houses?

28. What is said of cases of poisoning? What care should be used to prevent accidental poisoning?

29. What should be done in all cases of poisoning? How may vomiting be produced? How may it be continued?

30. How may the patient's strength be supported?

SECTION II.

GLOSSARY OF DISEASES.

Anæ'mia. Poverty of blood.

An'eurism. A soft tumor formed in the course of an artery, by the dilatation of its coats. The rupture of these coats produces death by hemorrhage.

Ap'oplexy. Sudden loss of consciousness; usually produced by pressure upon the brain from an increased supply of blood.

Asphyx'ia. Suspended breathing from drowning, the inhalation of gases, chloroform, or ether.

Asth'ma. Difficulty of breathing, caused by a spasmodic constriction of the bronchial tubes.

Bronchi'tis. An inflammation of the mucous membrane of the bronchial tubes.

Car'buncle. An inflammation similar, but more extensive than a boil.

Cat'aract. A disease of the crystalline lens of the eye, causing dimness, and even loss of vision.

Catarrh'. Influenza. An epidemic disease, with the ordinary symptoms of "a bad cold," but often more severe.

Chil'blain. Frost-bite, particularly of the feet.

Chick'en-pox. Varicella. A mild, contagious disease, attended with an eruption on the skin. The time between the exposure and attack, lasts four or five days.

Chore'a. St. Vitus's Dance. A disease causing incessant and irregular movements of the voluntary muscles, without the control of the will.

Chol'era. Asiatic Cholera. An epidemic disease, attended with diarrhœa, and with cramps in the limbs. Often very fatal, but not contagious. It first visited this country in 1832; and a second time in 1849, lingering until 1854.

Chol'era Infant'um. The summer complaint of young children; and mostly confined to cities.

Chol'era Mor'bus. A disease attended with vomiting and diarrhœa; often produced by eating stale or unripe fruit.

Col'ic. Pain in the abdominal region, often attended with cramp.

Congest'ive Fever. Pernicious Fever. A fever occurring in marshy places, especially near the rice plantations of the Southern States. About one in eight cases die.

Conjunc'tivitis. Inflammation of the conjunctiva of the eye.

Convul'sions. The involuntary contraction of the muscles, during which the body is rigid, and the consciousness absent.

Cornei'tis. Inflammation of the cornea of the eye.

Coxal'gia. Hip-disease.

Delir'ium Tre'mens. Mania a potû. Caused by the excessive use of alcoholic stimulants.

Diphthe'ria. Putrid sore throat, often very fatal among children. Epidemic, and probably contagious in the malignant forms. It was epidemic in this country from 1856 to 1862. Washington died of diphtheria.

Dys'entery. An inflammation of the large intestine, often becoming endemic, and then more dangerous.

Dyspep'sia. Indigestion of food, usually produced by irregular habits of living.

Ear'ache. Otalgia. Pain in the ear. Three drops of sweet-oil, or rabbit's fat, and two drops of laudanum, dropped into the ear, will generally relieve it.

Endocardi'tis. Inflammation of the lining membrane of the heart.

Ep'ilepsy. Periodical convulsions, with unconsciousness during the attacks.

Erysip'elas. St. Antony's Fire. An inflammation of the skin, usually beginning in the face, and spreading to other parts. Sometimes epidemic.

Fel'on. Whitlow. An inflammation of a finger or thumb, often causing a loss of one or more of the bones.

Gastri'tis. Inflammation of the stomach.

Gout. Pain, mostly in the small joints, which frequently become swollen, red, and very tender.

Hem'orrhage. Bleeding from any part of the body.

Hem'orrhoids. Piles. Tumors at the lower extremity of the rectum.

Hydroceph'alus. Water in the head; dropsy of the brain.

Hydropho'bia. A disease produced by the bite of a mad or rabid dog.

Hyste'ria. A morbid excitability of the nervous system, more or less uncontrollable.

Intermit'tent Fever. Chills and Fever. Ague. It occurs mostly in spring or autumn, and in the vicinity of marshes, ponds, or slow streams of water. Seldom fatal.

Jaun'dice. A disease of the liver, attended by a yellowness of the skin. Sometimes epidemic.

Laryngi'tis. Inflammation of the larynx.

Lock-jaw. Tetanus. A disease in which there is a continued contraction or stiffness in the voluntary muscles. This usually begins in the muscles of the jaws. Most cases die within a week.

Mea'sles. Rubeola. A contagious disease, attended with an eruption on the skin. The time between the exposure and attack, lasts from ten to fifteen days.

Meningi'tis. An inflammation of the meningeal membrane of the brain.

Mumps. A contagious inflammation of the parotid gland.

Neural'gia. Pain in a nerve, without inflammation. It is called tic douloureux, when in the face, and sciatica, when in the hip.

Pal'sy. A paralysis or loss of motion, more or less complete, in the muscles of one side.

Pericardi'tis. An inflammation of the membrane investing the heart.

Peritoni'tis. An inflammation of the peritoneum, or serous membrane lining the abdomen.

Pharyngi'tis. The ordinary sore throat. Inflammation of the pharynx.

Phthi'sis Pulmonal'is. Consumption of the lungs. A disease which continues to destroy the substance of the lungs, until there is not enough left to support life.

Pleu'risy. An inflammation of the pleura, or membrane covering the lungs.

Pneumo'nia. An inflammation of the substance of the lung.

Pleu'ro-pneumo'nia. Pleurisy and pneumonia. An inflammation, both of the lung and the pleura covering it.

Quin'sy. Tonsillitis. An inflammation of the tonsil glands.

Remit'tent Fever. Bilious Fever. Occurring mostly in spring or autumn, and in the vicinity of marshes, ponds, or slow streams of water. More severe than Intermittent Fever. Often fatal.

Rheu'matism. Pain confined mostly to the larger joints, which frequently become swollen, red, and very tender.

Rick'ets. A disease, attended with a curving of the spinal column, or of the limbs, in young children.

Scar'let Fever. Scarlatina. A disease attended with sore throat, and a bright red eruption on the skin. Most writers consider it contagious. Often very fatal. The time between the exposure and attack, lasts about five days.

Scrof'ula. A disease which causes a wasting of the substance of the body, and which is produced by hereditary transmission, or by the want of proper food, clothing, and fresh air. It is apt to end in Consumption of the lungs.

Scur'vy. Scorbutus. A disease attended by swelling and bleeding of the gums, lowness of spirits, and general debility; and produced by want of fresh, vegetable food.

Small-pox. Variola. A contagious disease, attended with an eruption on the skin, and often very fatal. The time between the exposure and the attack, lasts about twelve days. The best preventive is vaccination.

Spot'ted Fever. Cerebro-spinal Fever. A very fatal, epidemic fever; but probably not contagious. More than half the cases die. First visited this country in 1806.

Sun'stroke. Unconsciousness, caused by excessive heat. A wet sponge or towel in the crown of the hat is the best preventive.

Tooth'-ache. Odontalgia. When the nerve is exposed, creosote will stop the aching. Place a small piece of cotton, wet with creosote, in the tooth. Oil of cloves is a good remedy, used in the same way.

Ty'phus Fever. Ship Fever. Camp Fever. Jail Fever. A contagious fever, caused by living in overcrowded and filthy places. About one case in twenty dies.

Ty'phoid Fever. Nervous Fever. A very slow fever produced by foul air, fatigue, and other depressing causes. Not contagious. About one case in twenty dies.

Whoop'ing-cough. Pertussis. A contagious disease, at-

tended with a cough, which causes a whooping sound. The time between the exposure and attack, lasts about six days.

Yel'low Fever. A very fatal epidemic fever, not usually considered contagious. It occurs most frequently in warm climates. About one case in three dies.

GLOSSARY OF WORDS.

Ab do' men. The large cavity in the front part of the body, between the chest and the pelvis. It contains the stomach, liver, and other digestive organs.

A ce tab' u lum. The cup-like cavity in the hip-bone. It receives the head of the thigh-bone.

A chil' les. The name of the tendon which joins the large muscles of the calf of the leg to the heel.

Ad' i pose Tis' sue. Tissue composed of fat.

Al bu' men. An animal substance resembling the white of an egg.

Al bu' mi noid Substances. A class resembling albumen, and obtained from both the animal and vegetable kingdom.

Al' ve o lar. Pertaining to the sockets of the teeth.

A nas' to mose. To communicate with each other, as one artery with another.

A nat' o my. The study of the structure and the position of the organs of the body while in a state of rest.

A or' ta. The largest artery of the body.

A rach' noid. One of the membranes covering the brain.

Ar' te ry. A tube which conveys blood away from the heart.

Ar tic u la' tion. A joint.

At' las. The first vertebra next to the head.

A ryt' e noid. One of the cartilages of the larynx.

Aud' i to ry Nerve. The nerve of hearing.

Au′ ri cles. The two cavities of the heart next to its base.

Ax il′ la. The armpit.

Bi cus′ pid. A tooth having two points or two fangs.

Bile. The secretion of the liver.

Brach′ i al. Belonging to the arm.

Bron′ chi. The two divisions or branches of the trachea.

Cæ′ cum. The name given to the commencement of the large intestine.

Ca nine′. Like a dog.

Cap′ il la ry. A small blood-vessel.

Car′ di ac. The orifice of the stomach next to the œsophagus.

Car niv′ o rous. Feeding upon flesh.

Ca rot′ id. The large artery on each side of the neck.

Car′ pus. The wrist.

Car′ ti lage. Gristle. An elastic substance softer than bone, but harder than a ligament.

Cas′ ein. The substance which coagulates in milk.

Cer e bel′ lum. The lower and smaller division of the brain; the little brain.

Cer′ e brum. The upper and larger division of the brain; the large brain.

Ce ru′ men. Ear-wax.

Cer′ vi cal. Relating to the neck.

Chlor′ ide of So′ di um. Common salt.

Cho′ roid. One of the coats of the eyeball.

Chyle. A milky-looking fluid consisting of food in a digested state.

Cil′ ia ry. Belonging to the eyelids.

Clav′ i cle. The collar-bone.

Coch′ le a. A part of the internal ear.

Co′ lon. A portion of the large intestine.

Con junc′ ti va. The mucous membrane lining the eyelids, and covering the front of the eyeball.

Cor′ ne a. The name of a membrane in the front part of the eyeball.

Cra′ ni um. The skull.

Cri′ coid. A cartilage of the larynx.

Crys′ tal line Lens. A double convex lens in the front part of the eyeball.

Cu′ ti cle. The external layer of the epidermis.

De cus sa′ tion. A crossing of fibres from side to side.

Den′ tal. Pertaining to the teeth.

Den′ tine. The ivory of the teeth.

Derm′ is. The deeper layer of the skin.

Di′ a phragm. A muscle separating the cavity of the chest from the abdomen.

Di ges′ tion. The process by which food is changed, so as to be absorbed into the system.

Dor′ sal. Relating to the back.

Du o de′ num. The part of the small intestine next to the stomach.

Du′ ra Ma′ ter. The external membrane of the brain.

En am′ el. The hard substance covering the crown of each tooth.

En do car′ di um. The membrane lining the interior of the heart.

Ep i derm′ is. The external layer of the skin.

Ep i glot′ tis. A cartilage covering the glottis.

Ep i the′ li um. The free surface of serous and mucous membranes.

Eu sta′ chi an. A tube or canal leading from the middle ear to the throat.

Fas′ cia. The sheath of a muscle.

Fas cic′ u li. Bundles of muscular fibres.

Fem′ o ral. Pertaining to the femur, or thigh-bone.

Fib′ u la. The small bone of the leg.

Fi′ brin. The substance in the blood which coagulates, or forms a clot.

Fo ra′ men. An aperture in a bone.

Gan′ gli on. An enlargement in the course of a nerve.

Gas′ tric. Pertaining to the stomach.

Gas troch ne' mi us. The name given to the large muscle forming the calf of the leg.

Gland. An organ which secretes and pours forth a liquid from one or more ducts.

Glos' so - pha ryn' ge al. The nerve of taste.

Glot' tis. The narrow opening at the top of the larynx.

Hem' or rhage. Bleeding from any part of the body.

Her biv' or ous. Feeding on plants.

Hu' mer us. The arm-bone next to the shoulder.

Hy' a loid. A thin membrane of the eye.

He pat' ic. Relating to the liver.

Hy' gi ene. The study of the best means for preserving the body in a state of health.

Hy' oid. The bone at the root of the tongue.

Il' e um. The lower portion of the small intestine.

In ci' sor. The name of a front tooth.

In ter cos' tal. Between the ribs.

In tes' tine. The part of the alimentary canal below the stomach.

I' ris. The ring surrounding the pupil of the eye.

Je ju' num. A portion of the small intestine.

Ju' gu lar. The large vein on each side of the neck.

Lab' y rinth. The internal ear.

Lach' ry mal. Pertaining to the tears.

Lac' te als. The vessels which absorb chyle from the small intestine.

Lar' ynx. The upper part of the windpipe.

Lig' a ment. A strong, fibrous membrane giving strength to the joints.

Liv' er. A large gland in the right side of the abdomen, just beneath the diaphragm.

Lymph. The colorless fluid in the lymphatic vessels.

Mar' row. A soft, fatty substance in the cavities of the bones.

Mas ti ca' tion. The act of chewing.

Med' ul la ry. Pertaining to marrow.

Me dul' la Ob lon ga' ta. That part of the nervous cord which joins the spinal cord to the brain.

Met' a-car' pus. The part of the hand between the fingers and the wrist; the palm of the hand.

Mi' tral. The valve between the left auricle and the left ventricle.

Mo' lar. The name of a back tooth, or grinder.

Mo' tor. Causing motion.

Mu' cous Mem' brane. A membrane lining all cavities which open externally.

Mu' cus. The fluid secreted by a mucous membrane.

Mus' cles. The fleshy or lean parts of the body.

Na' sal. Pertaining to the nose.

Neu ri lem' ma. The sheath of a nerve.

Oc cip' i tal. Relating to the back part of the head.

Œ soph' a gus. The tube extending from the throat to the stomach.

Ol fac' to ry. Pertaining to the sense of smell.

O men' tum. A fold of serous membrane covering the intestines; the caul.

Op' tic. Pertaining to the sight.

Or' gan. Any part of the body capable of a special function.

Os' se ous. Pertaining to the bones.

Os' si fy. To change into bone.

Pal' ate. The roof of the mouth.

Pal' mar. Relating to the palm of the hand.

Pal' pe bral. Relating to the eyelids.

Pan' creas. A gland behind the stomach.

Pa pil' la. A minute prominence.

Pa rot' id. The largest of the salivary glands.

Pa tel' la. The knee-pan; the cap of the knee.

Pec' to ral. Pertaining to the chest.

Pel' vis. The basin formed by the hip-bones, the sacrum, and the coccyx.

Per i car' di um. The membrane enclosing the heart.

Pe ri os' te um. A fibrous membrane covering the bones.

Per i to ne' um. The serous membrane investing the stomach, intestines, and abdomen.

Phar′ ynx. The throat.

Phys i ol′ o gy. The study of the functions of the organs of the body; or the study of the phenomena of life.

Pi′ a Ma′ ter. The inner membrane of the brain.

Plas′ ma. The liquid part of the blood.

Pleu′ ra. A serous membrane covering the lung and lining the chest.

Plex′ us. A network of nerves.

Pneu mo gas′ tric. The principal nerve of respiration.

Pons. A division of the brain in front of the cerebellum.

Prim′ i tive Cell. The starting point in the formation of a living body.

Pul′ mo na ry. Belonging to the lungs.

Pu′ pil. The opening in the eye through which the rays of light pass to the retina.

Py lor′ us. The orifice of the stomach next to the small intestine.

Ra′ di us. A bone of the forearm.

Rec′ tum. The lower portion of the large intestine.

Res pi ra′ tion. The breathing of air into and out of the lungs.

Ret′ i na. The coat of the eye formed by the expansion of the optic nerve.

Sa′ crum. A bone of the pelvis.

Sa li′ va. The fluid secreted by a salivary gland.

Scap′ u la. The shoulder-blade.

Scle rot′ ic. A membrane of the eye.

Se ba′ ceous. Pertaining to fat.

Sem i lu′ nar Valves. The valves at the commencement of the pulmonary artery, and of the aorta.

Se′ rum. The watery part of the blood; also, the fluid secreted by serous membranes.

Se′ rous Mem′ brane. A membrane lining all cavities which do not open externally.

Sin′ ew. A cord by which a muscle is attached to a bone.

Skel′ e ton. The bones, or frame-work of the body.

Ster′ num. The breast-bone.

Stom′ ach. A large pouch in the left side of the abdomen, just beneath the diaphragm.

Sub cla′ vi an. Situated under the clavicle.

Sub lin′ gual. Situated under the tongue.

Su′ tures. The joints between the bones of the skull.

Syn o′ vi a. The fluid which lubricates the joints.

Tar′ sus. The bones forming the heel and the instep of the foot.

Ten′ don. The cord by which a muscle is attached to a bone.

Tho′ rax. The chest.

Tib′ i a. The large bone of the leg; the shin-bone.

Tis′ sue. The texture of which any part of the body is composed.

Ton′ sil. A gland in the throat.

Thy′ roid. A cartilage of the larynx.

Tra′ che a. The windpipe.

Tri cus′ pid. The valve between the right auricle, and the right ventricle.

Tym′ pa num. The middle ear; the drum of the ear.

Ul′ na. A bone of the forearm.

U′ vu la. A soft body attached to the palate.

Vas′ cu lar. Containing blood-vessels.

Vein. A tube which conveys blood towards the heart.

Ven′ tri cles. The two cavities of the heart next to its apex.

Ver′ te bra. The name given to each bone of the spinal column.

Ves′ ti bule. A part of the internal ear.

Vil′ li. Elevations in the mucous coat of the small intestine.

Vit′ re ous. A humor of the eye.

INDEX.

A

MODEL TEXT-BOOKS

FOR

Schools, Academies, and Colleges.

CHASE AND STUART'S CLASSICAL SERIES.

EDITED BY

THOMAS CHASE, A.M.,
PROFESSOR OF CLASSICAL LITERATURE, HAVERFORD COLLEGE, PENNA.

GEORGE STUART, A.M.,
PROFESSOR OF THE LATIN LANGUAGE, CENTRAL HIGH SCHOOL, PHILADA.

AND

E. P. CROWELL, A.M.,
PROFESSOR OF LATIN IN AMHERST COLLEGE.

REFERENCES TO

HARKNESS'S LATIN GRAMMAR,
ANDREWS & STODDARD'S LATIN GRAMMAR,
BULLIONS & MORRIS'S LATIN GRAMMAR,
GILDERSLEEVE'S LATIN GRAMMAR,
ALLEN'S MANUAL LATIN GRAMMAR,
AND
ALLEN & GREENOUGH'S LATIN GRAMMAR.

THE publication of this edition of the Classics was suggested by the constantly increasing demand by teachers for an edition which, by judicious notes, would give to the student the assistance really necessary to render his study profitable, furnishing explanations of passages difficult of interpretation, of peculiarities of Syntax, &c., and yet would require him to make faithful use of his Grammar and Dictionary.

It is believed that this classical Series needs only to be known to insure its very general use. The publishers claim for it peculiar

merit, and beg leave to call attention to the following important particulars:

The purity of the text.
The clearness and conciseness of the notes, and their adaptation to the wants of students.
The beauty of type and paper.
The handsome style of binding.
The convenience of the shape and size.
The low price at which the volumes are sold.
The preparation of the whole Series is the original work of American scholars.
The text is not a mere reprint, but is based upon a careful and painstaking comparison of all the most improved editions, with constant reference to the authority of the best manuscripts.
No pains have been spared to make the notes accurate, clear, and helpful to the learner. Points of geography, history, mythology, and antiquities are explained in accordance with the views of the best German scholars.

The generous welcome given to these books, proves very conclusively that they are well adapted to the wants of the class-room. They have been adopted in every State of the Union, and we have the proud satisfaction of stating that they are at this time the standard text-books in more than

One Thousand Schools,

and the number is daily increasing. Among these are many of the largest and most important classical institutions in the country.

The Publishers desire to acknowledge their indebtedness to the teachers of Latin throughout the country who are using these books, for the high position that has been accorded to them. Grateful for the very flattering welcome they have received, we pledge ourselves that the entire Series shall be

In Scholarship — Inferior to None.
In Appearance — The Most Attractive.
In Binding — The Most Durable.
In Price — The Most Reasonable.

To those teachers who do not use them we suggest the consideration of two facts:

1. **Large and permanent success follows only real merit.**
2. **Such success has been obtained by these books.**

And we are confident that if they will inquire into the merit which has insured this success, they will find that they are well worthy of the commendation bestowed upon them.

The Series contains the following works, viz.:

CÆSAR'S COMMENTARIES on the Gallic War. With Explanatory Notes, Lexicon, Geographical Index, Map of Gaul, Plan of the Bridge, &c. By Prof. GEORGE STUART. Price by mail, postpaid, $1.25.

FIRST SIX BOOKS OF VIRGIL'S ÆNEID, with Explanatory Notes, Lexicon, Remarks on Classical Versification, Index of Proper Names, &c. By Prof. THOMAS CHASE. Price by mail, postpaid, $1.25.

VIRGIL'S ÆNEID. With Explanatory Notes, Metrical Index, Remarks on Classical Versification, Index of Proper Names, &c. By Prof. THOMAS CHASE. Price by mail, postpaid, $1.50.

VIRGIL'S ECLOGUES, GEORGICS, AND MORETUM. With Explanatory Notes, Lexicon, &c. By Prof. GEORGE STUART. Price by mail, postpaid, $1.25.

CICERO'S SELECT ORATIONS. With Explanatory Notes, Lexicon, Life of Cicero, List of Consuls during his Life, Plan of the Roman Forum and its Surroundings, &c. By Prof. GEORGE STUART. Price by mail, postpaid, $1.50.

SALLUST'S CATILINE AND JUGURTHINE WAR. With Explanatory Notes, Lexicon, &c. By Prof. GEORGE STUART. Price by mail, postpaid, $1.25.

CORNELIUS NEPOS. With Explanatory Notes, Lexicon, &c. By Prof. GEORGE STUART. Price by mail, postpaid, $1.25.

HORACE'S ODES, SATIRES, AND EPISTLES. With Explanatory Notes, Metrical Key, Index of Proper Names, &c. By Prof. THOMAS CHASE. Price by mail, postpaid, $1.50.

LIVY. BOOKS I., XXI. AND XXII. With extracts from Books IX., XXVI., XXXV., XXXVIII., XXXIX., and XLV. With Explanatory Notes, Geographical Index, &c. By Prof. THOMAS CHASE. Price by mail, postpaid, $1.50.

CICERO DE SENECTUTE ET DE AMICITIA. With Explanatory Notes, &c. By E. P. CROWELL, A.M., Professor of Latin, and H. B. RICHARDSON, Instructor of Latin in Amherst College. Price by mail, postpaid, $1.25.

CICERO DE OFFICIIS. With Explanatory Notes, &c. By E. P. CROWELL, A.M., Professor of Latin in Amherst College. Price by mail, postpaid, $1.50.

CICERO'S TUSCULAN DISPUTATIONS. Book First. The Dream of Scipio, and Extracts from the Dialogues on Old Age and Friendship. With Explanatory Notes. By Prof. THOMAS CHASE. Price by mail, postpaid, $1.25.

A

SERIES OF TEXT-BOOKS

ON THE

ENGLISH LANGUAGE.

By JOHN S. HART, LL.D., Professor of Rhetoric and of the English Language in the College of New Jersey.

The Series comprises the following volumes, viz.:

First Lessons in Composition,	Price,	$0.90
Composition and Rhetoric,	"	1.50
A Short Course in Literature,	"	1.50

And for Colleges and Higher Institutions of Learning:

A Manual of American Literature,	"	2.50
A Manual of English Literature,	"	2.50

Hart's First Lessons in Composition is intended for beginners. A greater help to the Teacher never was invented. It will revolutionize the whole work of teaching. By the increased power of expression which it gives to the pupil, it doubles his progress in every study. There is not a school but in which a class can be formed for its advantageous use. Any pupil able to read tolerably well can use it to advantage.

Hart's Composition and Rhetoric has been prepared with a full knowledge of the wants of both teacher and scholar in this important branch of education, and the author has spared no pains to make the book eminently practical and adapted to use in the class-room. Dr. Hart has been engaged for more than one-third of a century in the practical duties of the school-room, and for years past has made a specialty of the subject of which the present volume treats. The great variety and copiousness of the "Examples for Practice" will commend the book to general favor. In this respect it is unequalled by any similar work heretofore published.

Hart's Short Course in Literature, English and American, is intended as a text-book for Schools and Academies. It is designed for the use of those who have not the time to devote to the study of Literature as laid down in the larger books of the Series.

Hart's Manual of English Literature is intended as a text book for Colleges, and as a book of reference.

Hart's Manual of American Literature is a companion volume to the "English Literature," with which it corresponds in general character and design. It is intended as a text-book for Colleges, and as a book of reference.

In these volumes Prof. Hart has embodied the matured fruits of his life-long studies in this department of letters. We believe they will be found in advance of any other text-books on the subject, in the comprehensiveness of the plan, the freshness of much of the materials, the sound judgment shown in the critical opinions, the clearness with which the several topics are presented, and the beauty as well as the practical convenience of the mechanical arrangements.

The scholarly culture and excellent literary judgment displayed, entitle these books to a high place among the works on English literature. The plan and arrangement present many novel features, and the thoroughness of detail, brevity and precision of statement, elegance of style, and soundness of opinion which characterize the volumes, call for the sincerest commendation.

ANATOMY, PHYSIOLOGY, AND HYGIENE. A Text-Book for Schools, Academies, Colleges, and Families. By JOSEPH C. MARTINDALE, M.D., late Principal of the Madison Grammar School, Philadelphia. Price by mail, postpaid, $1.30.

The study of Physiology and the Laws of Health is as important as it is interesting. Its importance has become so generally recognized that there are now few schools in which it does not occupy a prominent position in the course of instruction. Dr. Martindale's Anatomy, Physiology, and Hygiene presents the following claims to the consideration of teachers. Technicalities have been avoided, so far as consistent with the treatment of the subject. The style in which it is written is not only pleasing, but such as to be readily comprehended by those for whose use it is designed. Superfluous matter has been omitted, so that the book can be completed in a much shorter period than any other text-book on the subject as yet published.

Descriptive circular sent on application.

FIRST LESSONS IN NATURAL PHILOSOPHY. For Beginners. By JOSEPH C. MARTINDALE, M.D., late Principal of the Madison Grammar School. Price by mail, postpaid, 60 cents.

This book is what its title indicates, "First Lessons in Natural Philosophy;" and it presents each division of the subject in such an easy and familiar style, that it cannot fail to interest and instruct any child of ordinary intelligence. Beginning as it does in a simple and easy manner, it secures the interest of the pupil by first directing his attention to objects in nature with which he is familiar. When the interest is thus excited, the subject is gradually unfolded by presenting, one after another, the familiar things met with in the every-day walks of life; thus, the most common objects are made the means of teaching great philosophical truths. Only so much of the subject is presented as can be taught with profit in our public and private schools, yet what has been given will be found to embrace all the more common phenomena met with in every-day life. The facts are so clearly and so plainly set forth, that they are en-

tirely capable of comprehension by those for whose use and benefit this little work is designed.

Teachers interested in the "Object Lesson" system of teaching will find this little book a valuable aid, in furnishing subjects for discussion.

Circular containing specimen pages, &c., sent to any address on application.

AN ELEMENTARY ALGEBRA, FOR SCHOOLS AND ACADEMIES. By JOSEPH W. WILSON, A.M., Professor of Mathematics in the Philadelphia Central High School. Price by mail, postpaid, $1.25.

The present work is the result of an effort to produce an Elementary Algebra suited to the wants of classes commencing the study. It has been prepared by one who for years has felt the need of just such a book, and is the fruit of long experience in the school-room.

With this book in hand, the pupil cannot help avoiding the difficulties which invariably present themselves at the very threshold of the study of Algebra.

It has been the aim to give such a presentation of the subject as will meet the wants of Common Schools and Academies. It is an *elementary* work, and no attempt has been made to include everything which might be brought under the head of Algebra. The treatment of the subject is on the principle of "step by step," so that the pupil at the very outset is inspired with a degree of confidence which induces self-reliance; rendering unnecessary a constant application to the teacher for help.

The book is commended to teachers in the hope that it will satisfy a need which the author has himself frequently felt.

Descriptive circular sent on application.

A KEY TO WILSON'S ELEMENTARY ALGEBRA, for the use of Teachers only. By Prof. JOSEPH W. WILSON, A. M. Price by mail, postpaid, $1.25.

THE CRITTENDEN COMMERCIAL ARITHMETIC AND BUSINESS MANUAL. Designed for the Use of Teachers, Business Men, Academies, High Schools, and Commercial Colleges. By JOHN GROESBECK, Consulting Accountant, and Principal of Crittenden's Philadelphia Commercial College. Price by mail, post-paid, $1.50.

In every High School and Academy in the land, the organization of a class in Commercial Arithmetic, Business Calculations and Forms, will prove an element of popularity and success that will yield rich results. The subject itself is so intrinsically valuable as a means of developing thought, that, were this the only result to be gained, it would be entitled to and should receive the special attention of the progressive teacher. But apart from this, the introduction of a study so interesting in itself, so attractive to the scholar, and having so direct a bearing on his future welfare, will, in many an instance, decide the welfare of a school, directing the channel of popular opinion in its favor, and prove the means of filling it with students anxious to secure its advantages.

Circulars containing full descriptive notice, testimonials, &c., will be sent to any address on application.

A MANUAL OF ELOCUTION. Founded upon the Philosophy of the Human Voice, with Classified Illustrations, Suggested by and Arranged to meet the Practical Difficulties of Instruction. By M. S. MITCHELL. Price by mail, post-paid, $1.50.

SUBJECTS TREATED OF.

Articulation, Pronunciation, Accent, Emphasis, Modulation, Melody of Speech, Pitch, Tone, Inflections, Sense, Cadence, Force, Stress, Grammatical and Rhetorical Pauses, Movement, Reading of Poetry, Action, Attitude, Analysis of the Principles of Gestures, and Oratory.

The compiler cannot conceal the hope that this glimpse of our general literature may tempt to individual research among its treasures, so varied and inexhaustible;—that this text-book for the

school-room may become not only teacher, but friend, to those in whose hands it is placed, and while aiding, through systematic development and training of the elocutionary powers of the pupil, to overcome many of the practical difficulties of instruction, may accomplish a higher work in the cultivation and refinement of character.

THE MODEL SPEAKER: Consisting of Exercises in Prose, Poetry, and Blank Verse, Suitable for Declamation, Public Readings, School Exhibitions, &c. Compiled for the Use of Schools, Academies, Colleges, and Private Classes, by Prof. PHILIP LAWRENCE. Price by mail, post-paid, $1.50.

The book is printed on superfine, tinted paper, and handsomely and durably bound in fine English cloth, with bevelled sides. For variety and freshness of selections, beauty of mechanical execution, and economy in price, it is unequalled by any similar work extant.

Great care has been taken to consult the authorized editions of the various writers represented, that the extracts from their works may be relied upon as accurate; though, in some instances, preference has been given to an early edition, when, in later issues, the alterations have not been deemed improvements. Many poems have been introduced which have never before found their way into any book of selections, being now for the first time published in this country in a permanent form.

It is believed that this book will be found admirably adapted for use as a "Reader," either in connection with any of the regular series of reading books, or to be taken up by classes that, having used the higher readers of the different series, need variety as an incentive to interest. For this purpose we particularly commend it to the attention of Principals of Academies, Seminaries, High Schools, Normal Schools, and Institutions for Young Ladies.

Descriptive Circular, containing entire List of Contents, sent to any address on application.

THE MODEL DEFINER. An Elementary Book for Beginners, containing Definitions, Etymology, and Sentences as Models, exhibiting the correct use of Words. By A. C. WEBB. Price by mail, post-paid, 25 cents.

THE MODEL ETYMOLOGY. Giving not only the Definitions, Etymology, and Analysis, but also that which can be obtained only from an intimate acquaintance with the best authors, viz.: the correct use of Words. With a Key containing the analysis of every word which could present any difficulties to the learner. By A. C. WEBB. Price by mail, post-paid, 60 cents.

The plan adopted in the Model Definer and Model Etymology is not new. All good Dictionaries illustrate the meaning by a Model. To quote from a good author, a sentence containing the word, as proof of its correct use, is the only authority allowed. A simple trial of the work, either by requiring the child to form sentences similar to those given, or by memorizing the sentences as models for future use, will convince any one of the following advantages to be derived from the Model Word-Book Series.

1. Saving of time.
2. Increased knowledge of words.
3. Ease to teacher and scholar.
4. A knowledge of the correct use of words.

Descriptive Circular sent on application.

MARTINDALE'S HISTORY OF THE UNITED STATES. From the Discovery of America to the close of the late Rebellion. By JOSEPH C. MARTINDALE, M.D., Principal of the Madison Grammar School, Philadelphia. Price by mail, post-paid, 60 cents.

With this book in his hand, the scholar can in a single school-term obtain as complete a knowledge of the History of the United States as has heretofore required double the time and effort.

Descriptive circular sent on application.

THE YOUNG STUDENT'S COMPANION; or, Elementary Lessons and Exercises in Translating from English into French. By M. A. LONGSTRETH, Principal of a Seminary for Young Ladies, Philadelphia. Price by mail, postpaid, $1.00.

TABLES OF LATIN SUFFIXES. Designed as an Aid to the Study of the Latin Grammar. By AMOS N. CURRIER, A.M., Professor of Latin in the University of Iowa. Price by mail, postpaid, 50 cents.

A FRENCH VERB BOOK; or, the New Expositor of Verbs in French. By ERNEST LAGARDE, A.M., Professor of Modern Languages in Mount St. Mary's College. Price by mail, postpaid, $1.00.

Lagarde's French Verb Book embraces a comprehensive analysis of the conjugations, a new method for the formation and use of the tenses, and a complete paradigm of all the verbs, the whole explained and exemplified by full illustrations. It is believed that the book will be found a valuable aid to the study of the French language.

COMPENDIUM OF FRENCH RULES. A Compendium of the Grammatical Rules of the French Language. By F. A. BRÉGY, A.M., Professor of French in the University of Pennsylvania.

IN THREE PARTS.

PART FIRST. Price by mail, postpaid, 75 cents.
PART SECOND. " " 50 "
PART THIRD. In Preparation.

These hand-books can be advantageously used in connection with any system. They lead the student from the first elements of the language to and through the principal rules of the French Syntax, enabling him, in a short time, to master intelligently what otherwise would prove a tedious and difficult task.

SELECTIONS FOR LITTLE FOLKS. A Book of Poetical Selections for Children. Price by mail, postpaid, 50 cents.

That sympathy which loves to link the present with the past, has prompted the preparation of this volume. Simply to make a child glad, is a worthy motive for storing its mind with poetic utterances, especially when the remembrance of such happiness becomes a well-spring of delight for a lifetime.

This little book is intended for children not more than nine or ten years of age, and the compiler would feel it a good excuse for adding another book to those already extant, should the little ones find pleasure in it.

IN THE SCHOOL-ROOM; or, CHAPTERS IN THE PHILOSOPHY OF EDUCATION. By JOHN S. HART, LL.D., Principal of New Jersey State Normal School. Price by mail, postpaid, $1.25.

This work gives the results of the experience and observation of the author "in the School-room" for a period of years extending over more than one-third of a century.

No teacher can afford to be without it.

It is a teacher's library in a single book.

Descriptive circular sent on application.

THE MODEL ROLL-BOOK, No. 1. For the Use of Schools. Containing a Record of Attendance, Punctuality, Deportment, Orthography, Reading, Penmanship, Intellectual Arithmetic, Practical Arithmetic, Geography, Grammar, Analysis, Parsing and History, and several blanks for special studies not enumerated. Price by mail, postpaid, $5.00.

THE MODEL ROLL-BOOK, No. 2. For the use of High Schools, Academies and Seminaries. Containing a Record of all the studies mentioned in Roll-Book No. 1, together with Declamation, Elocution, Algebra, Geometry, Composition, Rhetoric, French, Latin, Philosophy, Physiology, and several blanks for special studies not enumerated. Price by mail, post-paid, $5.00.

Since the first publication of the Model Roll-Books, they have been very materially improved. They have been made uniform in size and price; each page has been arranged to exhibit a record for one month, and space has been assigned for a monthly summary. These Roll-Books are in use in the leading schools in Boston, New York, Philadelphia, Baltimore, Cincinnati, Chicago, and St. Louis, and very extensively in Academies, Seminaries, and High Schools throughout the Country. They will, on examination, be found to be the most complete and practical yet published. All teachers who use them speak of them with unqualified approval.

THE MODEL POCKET REGISTER AND GRADE-BOOK. A Roll-Book, Record, and Grade-Book combined. Adapted to all grades of classes, whether in College, Academy, Seminary, High or Primary School. Handsomely bound in fine English cloth, bevelled sides, crimson edges. Price by mail, post-paid, 65 cents.

THE MODEL SCHOOL DIARY. Designed as an aid in securing the co-operation of parents. It consists of a Record of the Attendance, Deportment, Recitations, &c., of the Scholar, for every day in the week. At the close of the week it is to be sent to the parent or guardian for his examination and signature. Copies will be mailed to teachers for examination, post-paid, on receipt of ten cents. Price per dozen, by mail, post-paid, $1.05.

THE MODEL MONTHLY REPORT. The general character of the Monthly Report is the same as that of the Model School Diary, excepting that it is intended for a *Monthly* instead of a *Weekly* Report of the Attendance, Recitations, &c., of the Pupil. Copies will be mailed to teachers for examination, postpaid, on receipt of ten cents. Price per dozen, by mail, postpaid, $1.05.

BOOK-KEEPING BLANKS. Consisting of six blank books, as follows: Day Book, Cash Book, Ledger, Journal, Bill Book, and Book for Miscellaneous Exercises. Price for each book by mail, postpaid, 15 cents; or the entire set of six books by mail, postpaid, 90 cents.

These books have been prepared as a matter of practical convenience for students in Book-keeping. They can be used with any treatise, and will be sold singly or in sets, as may be desired.

Teachers corresponding with us are requested to supply us with a copy of the circular or catalogue of the school of which they are the Principal, or with which they are connected.

Descriptive circulars of all our publications will be sent to any address on application.

Please address,

ELDREDGE & BROTHER,
No. 17 North Seventh Street,
PHILADELPHIA.